AVIATION AND AERONAUTICAL ENGINEERING

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Georges Carpentier, French Aviator, Standing in Front of a Twin-Engined Warplane

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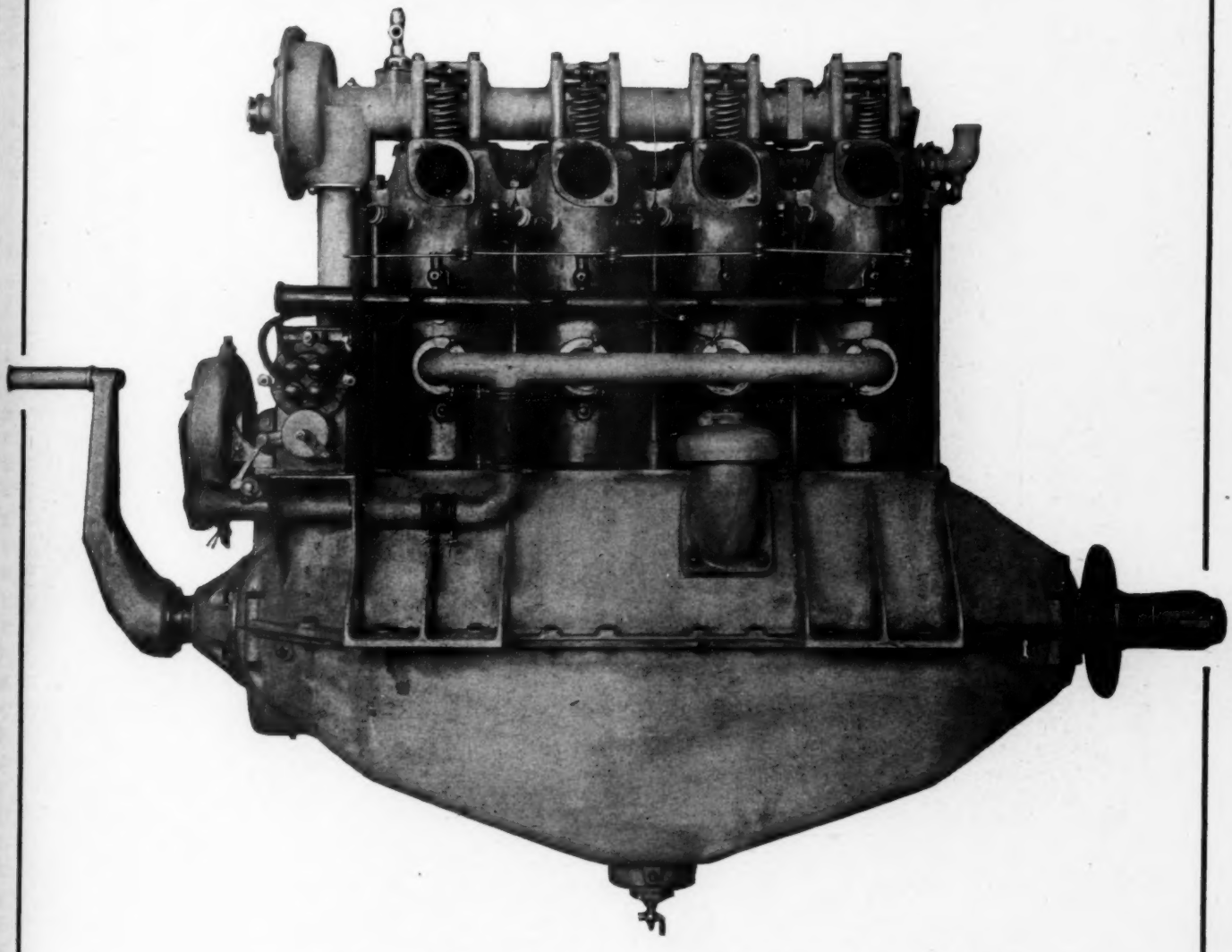

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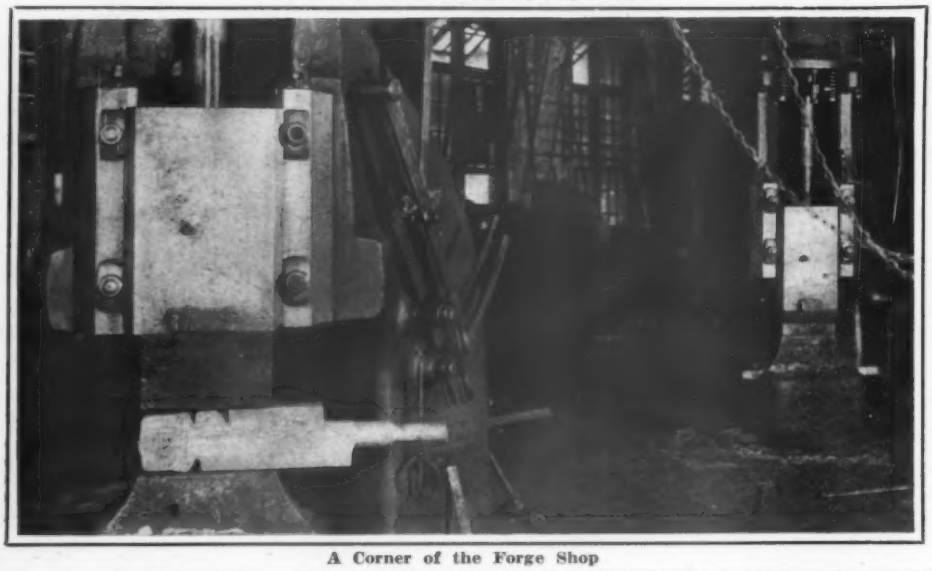

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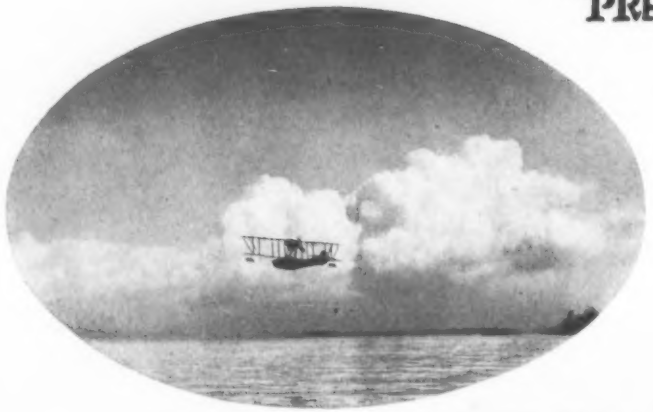

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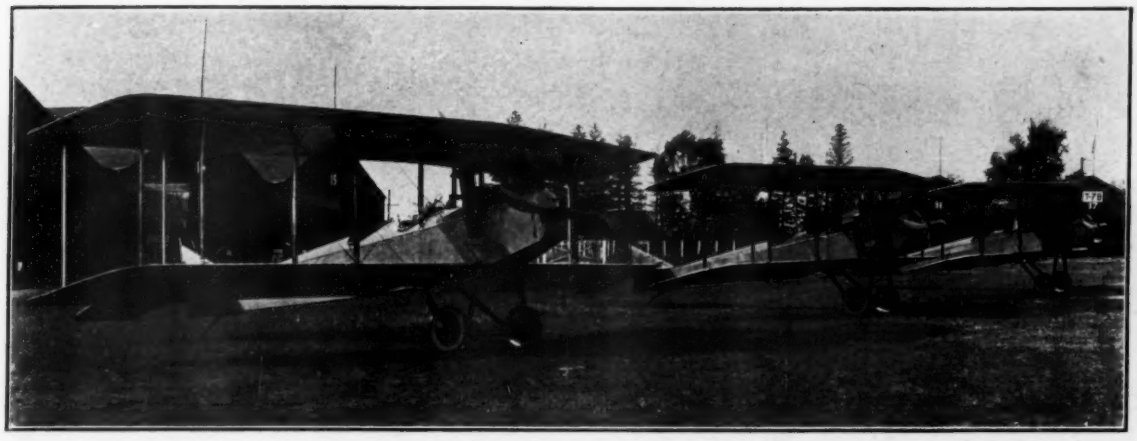

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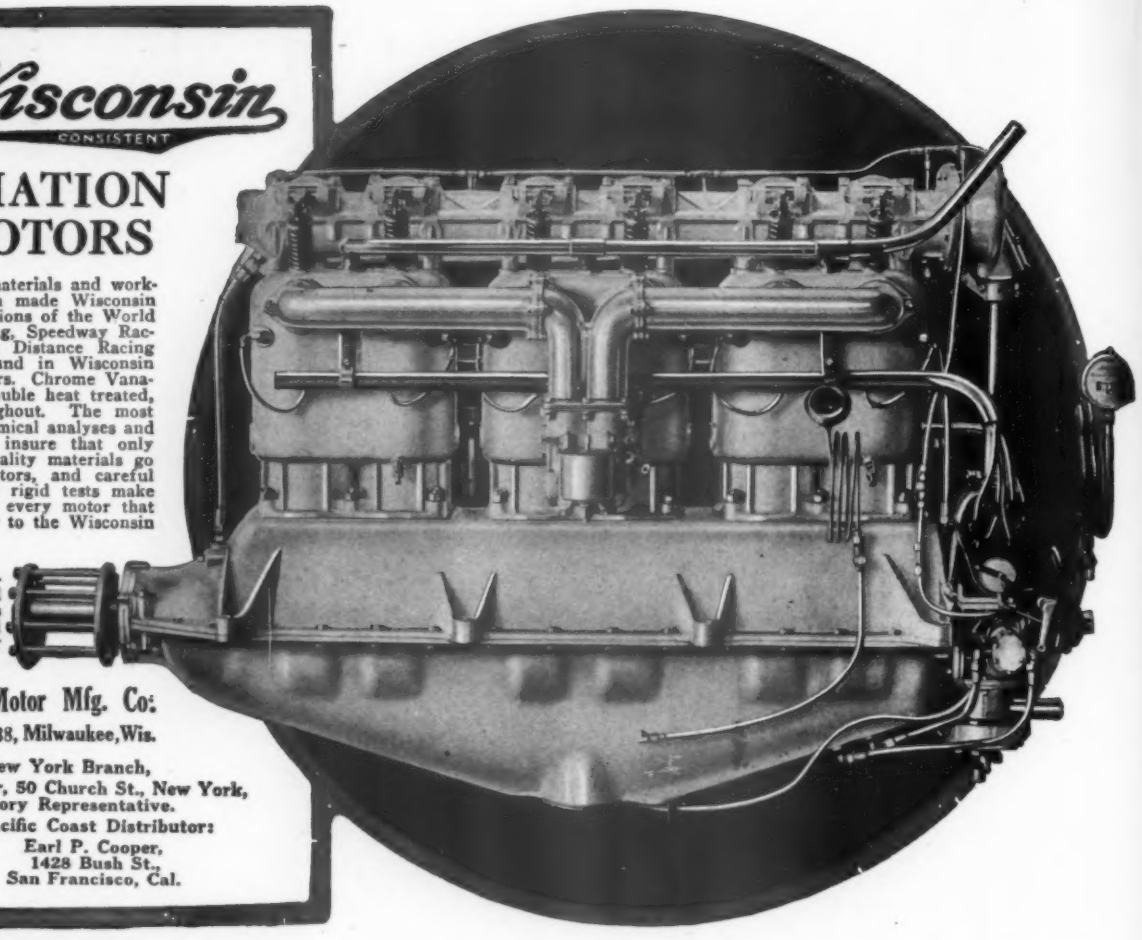

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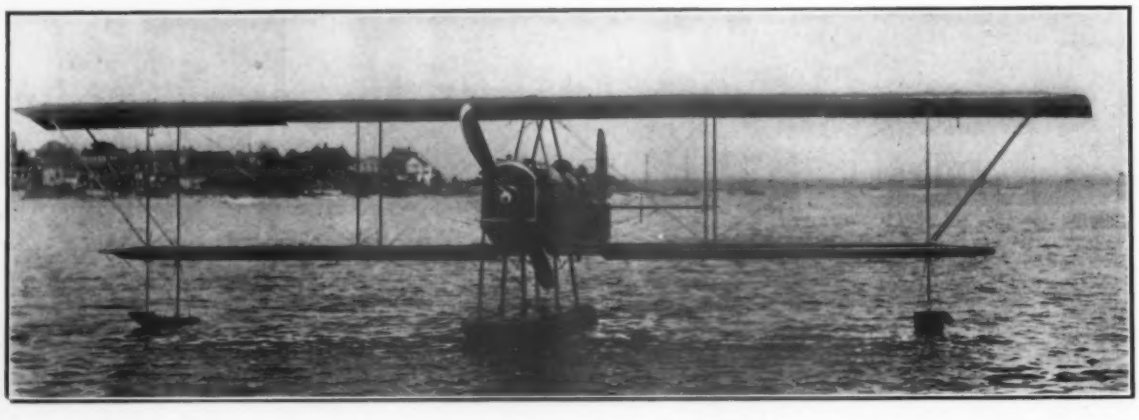

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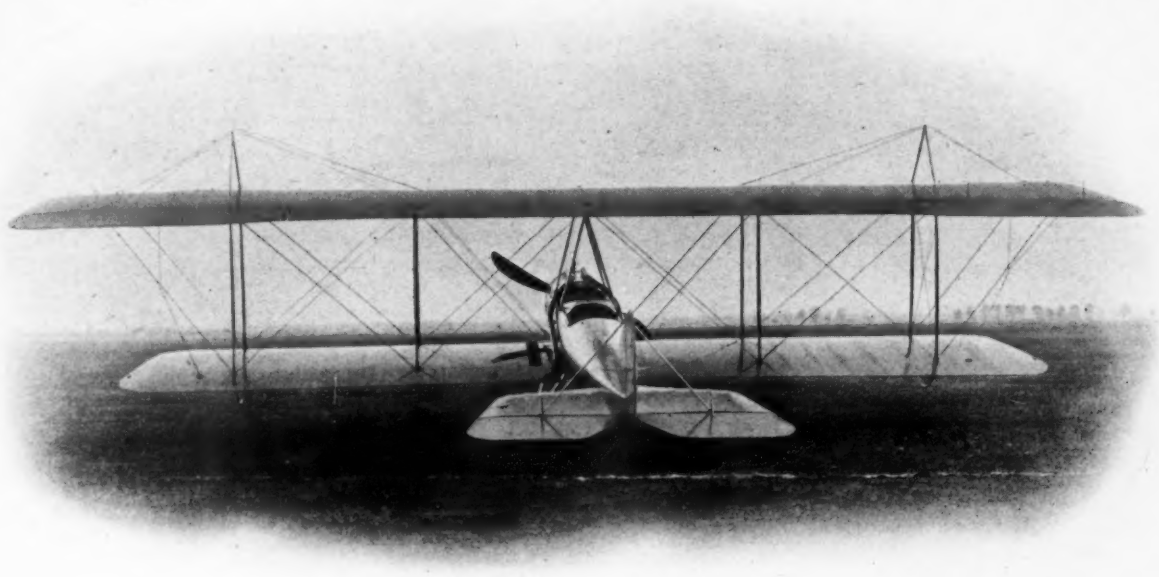

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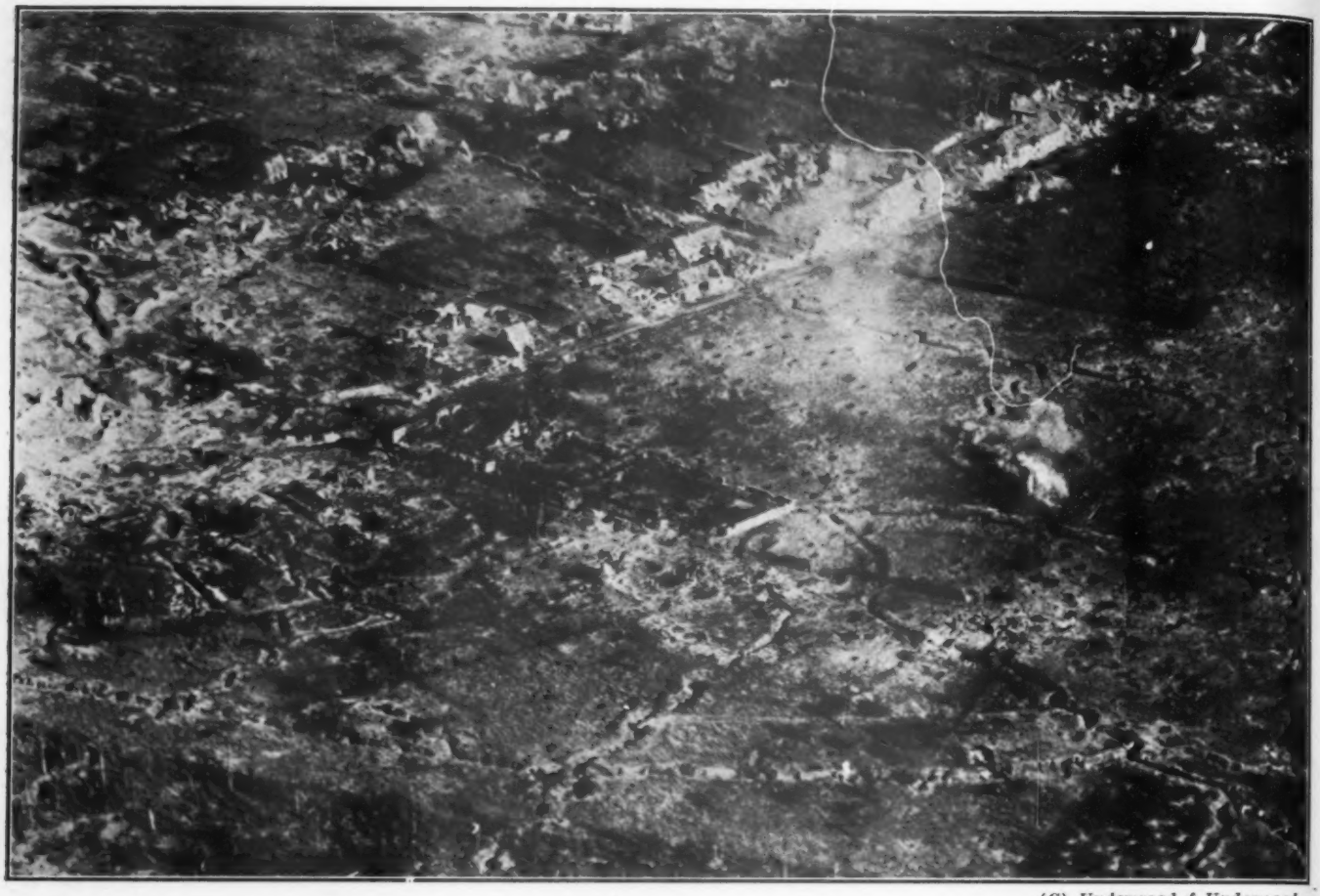

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Two views of the French attack on the outskirts of the village of Soyécourt. The town until recently was in German hands. Troops are plainly visible in many of the trenches and shell-craters are shown in both photographs.

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IN this issue of AVIATION AND AERONAUTICAL ENGINEERING, the Wright-Martin Aircraft Corporation license agreement is printed. The Curtiss Company has also notified constructors that it will expect royalties for the building of seaplanes under its patents. Until this question of basic patents is finally determined the aeronautic industry in this country will be in an unsettled condition. For this reason the sooner the matter is adjusted the better for the owners of the patents, the constructors and the Government.

There are clearly three parties to consider this agreement, the owners of the patents, the possible licensees and the Government. The latter has a direct interest as the chief purchaser of airplanes in this country and as the ultimate consumer who will have to pay the royalties. The possible licensees will have to determine the probable validity of the patents, while the owners of the patents will naturally make every effort to exact what in their judgment is a fair royalty.

It is unfortunate that no advantage was taken by sportsmen or the Government of the generous offer which the Wright Brothers made in 1907 to sell their patents for public use for $100,000. It is another lamentable instance of short-sightedness in dealing with such important inventions. Today conditions have altered. Aeronautics is thought of in large figures. Where thousands were considered extravagant ten years ago, millions are now regarded as inadequate for this increasingly important arm of military and naval service. Large investments have been made in the industrial development of airplanes and accessories. Realizing the ultimate scope of the industry, some of the most influential business men in the country have become interested in the construction of airplanes and aeromotors. The future is to be that of big business.

The proposed agreements call for licenses and the payment of royalties. Five per cent on the gross business is specified for the use of the Wright patent. The Curtiss royalty has not been announced as yet. There seems to be a general agreement that some payment would clear the situation and enable constructors to operate knowing their position clearly.

The whole problem then resolves itself into a question as to whether it is preferable to litigate or pay a royalty. As the agreement is not to be retroactive, the volume of business to be considered is from 1916 to 1923. With the five per cent royalty on the gross business, an average minimum of $10,000 a year is asked. This means that a concern will have to do a gross business of $200,000 a year to operate on this percentage as a fixed sum.

It is probable that these two facts will be more discussed than any others. Whether or not five per cent on the gross business is excessive is a matter of cost accounting which will have to be determined by each constructor. The owners of the patents will have to determine what protection from unlicensed competition they can guarantee to licensees. The minimum of $10,000 is also a most serious proviso, for many concerns would be deterred from entering the field with this annual payment definitely demanded.

It is quite probable that the Government will take some part in the settlement of this patent crisis. The Navy particularly has had many patent difficulties to meet and has managed to adjust claims to the satisfaction of patent owners. At the present time, it is merely a matter of adequate compensation. England reached an agreement with the Wrights and it would be unfortunate if the present necessities of this country for aerial equipment were crippled by delays by suits or negotiations of a protracted nature.

It is clearly a time for all interested to get together and reach a settlement so that the Army and Navy will secure equipment so urgently needed.

Aeronautics Is Now Favorably Considered

The hearings before the congressional committee on appropriations for aeronautics for the coming year have already shown that since early in 1916, a marked change in sentiment has taken place in Washington. A like condition is apparent in many different ways throughout the country, and the people as a whole are realizing the great progress being made in aeronautical development.

At the recent hearings, government aviation officials showed that their helpful policy of cooperating with constructors and motor makers, has resulted in decided advances in the industry and promises to be an important factor in placing it on a firm business basis. Just praise is heard from these officials of the airplanes and motors now being manufactured, and it is evident that confidence is felt in the future of the products of the leading American aeronautical manufacturers.

The year just closed has been notable for the commercial development of the industry and for the creation of a popular interest in aeronautics; the new year is bound to develop increasing general interest, and to yield advance in designing, better manufacturing efficiency and much greater factory output. The year 1917 will be a period of real expansion, and systematic production in a commercial sense will be undertaken on a broader scale.

AVIATION AND AERONAUTICAL ENGINEERING hopes that through its efforts in presenting technical information, it will in some measure assist the growth of this new industry on which the Nation is dependent for its protection and its peace.

The Present Day Aviatik*

By Jean Lagorgette

The present Aviatiks are tractor biplanes with stream-line bodies. Their dimensions are practically the same as those of all German biplanes whose evolution they followed. After having a wing spread almost double the length of the airplane, the wings were shortened, while the length of the body remained the same.

WINGS

The incidence of the wings to the propeller axis is 4 degrees 38 minutes throughout their spread, and there is no décalage. The planes since 1915 have had only a very slight dihedral,

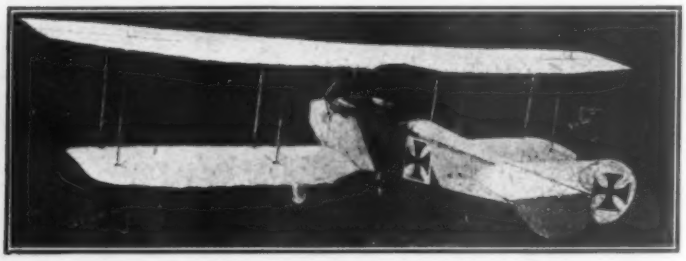

FIG. 1. AVIATIK OF 1916 TYPE.

The photograph shows the balanced rudder, large fixed stabilizer, fixed vertical fin, wings almost without dihedral or sweep back and ailerons on the upper planes.

about half a degree. As seen from above in Fig. 3, their shape is practically rectangular, almost forming a parallelogram, for the sweep back is barely more than 1 degree 10 minutes. On the last restored Aviatik the sweep back has been almost entirely eliminated. The spread of the upper wings is 40 feet 8.1 inches, while that of the lower ones, including the body, is 35 feet 5 inches. The chord measuring 6 feet 1 inch, and the gap of 6 feet 4 inches, are slightly greater than in the other German airplanes. The total surface of the wings is 430.56 square feet, including the surface of the ailerons.

The ailerons are fitted only to the upper planes, and their rear edges rise progressively near the ends of the wings, as will be seen by referring to Fig. 1. Each aileron measures 7 feet 3.6 inches by 2 feet 5.1 inches, and has an actual surface of 17.22 square feet. Like the wings, they are thicker set and

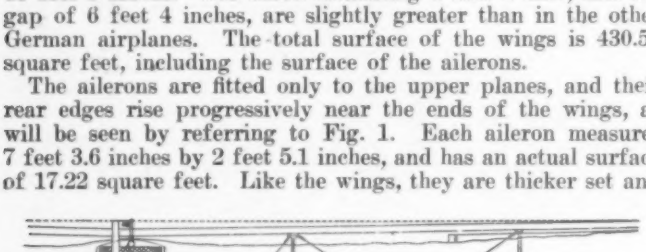

FIG. 2. FRONT ELEVATION OF THE TYPE AVIATIK IN SERVICE AT THE PRESENT TIME.

more compact than they formerly were, and though not as extended, are deeper.

TAIL

Like all German airplanes, the Aviatik has a large fixed stabilizer, which measures 4 feet 10.2 inches by 9 feet 2.2 inches. Its shape, almost a perfect half circle, as in the old monoplane and the first biplanes of the Nieuport concern, has undergone no change since 1913. The tail is a slightly lifting one, and is similar to that of the new Albatros.

Formerly the upper surface of the body upon which rested the stabilizing plane was in line with the axis of the engine, but making a slight angle with the fixed stabilizer. Now the body slopes downward at the rear, but the angle of incidence of the stabilizer is unchanged. Its angle of incidence to the wings is minus 0 degrees 58 minutes, and the extension of the crankshaft axis passes 5.51 inches beneath the rear of the stabilizing plane.

The elevator is composed of two semi-oval surfaces between which the rudder is pivoted, as shown in Fig. 1. The dimensions of each surface are 4 feet 3 inches by 2 feet 2 inches.

The rudder, which was originally shaped like a comma and without any fixed fin, later, in the 1914-15 type, became semi-circular with a fixed fin. It has now returned to its comma

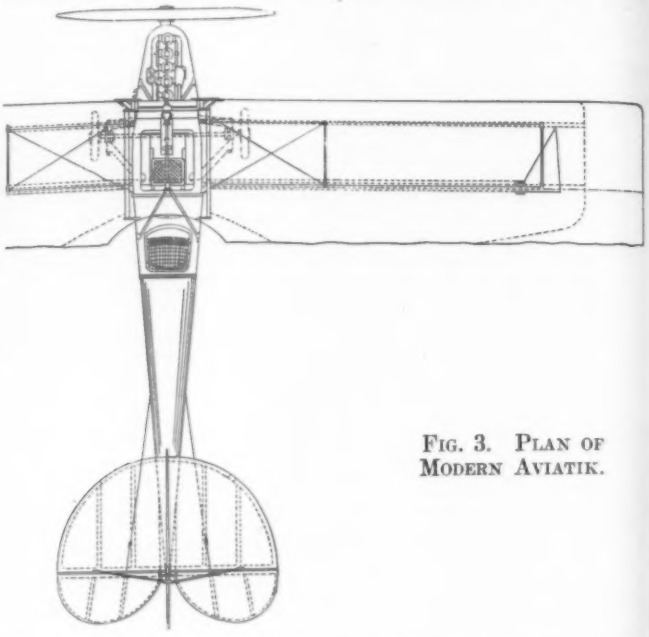

FIG. 3. PLAN OF MODERN AVIATIK.

shape, with a slight modification to admit of the fixed fin, which measures 5 feet 1 inch by 2 feet 5.5 inches, and is balanced. The dimensions are: Height, 3 feet; depth, 2 feet 3.5 inches, and the balancing part adds 10.63 inches to the depth.

The surface area of the elevator is 12.07 square feet, while the surface area of the fixed stabilizing plane, including the part covering the body, is 35.52 square feet. The surface area of the rudder is 6.45 square feet, inclusive of the balancing part, which measures .81 square feet in surface area. The surface area of the stationary fin measures 3.23 square feet.

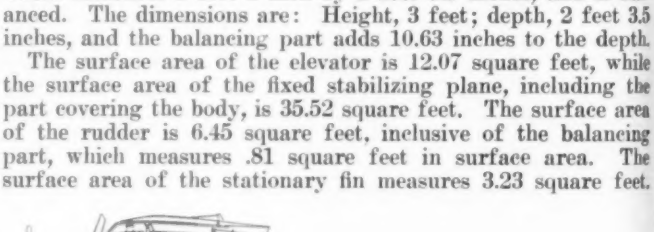

FIG. 4. SIDE ELEVATION OF 1916 MODERN AVIATIK.

The elevator, the rudder and the fixed vertical fin are built up of hollow steel tubing .47 inch outside diameter. The edges of the stationary stabilizer are of .98 inch hollow steel tubing, and its ribs are of wood. The front edges of the elevating surfaces are also of .98 inch hollow steel tubing.

The stationary stabilizer is fitted to the extreme rear end of the body, and is not built into the body as it is on the L.V.G. It is supported from below by four small tubes and connected with the fixed fin by two others. The tube constituting the rudder post, outside of the extremity of the body, rests on a sort of cup, as in the Rumpler and the L.V.G.

BODY

The length of the body, 11 feet 6 inches, is practically the same as that of the Albatros and of the Rumpler. It is built with box girder construction, rectangular in cross section, with diagonal stays of piano-wire. The whole is assembled, as before the war, with patented collars and couplings, which do away with all necessity of piercing the longerons. These collars consist of a single piece strip of steel wrapped around

* A digest of an article in *L'Aérophile*.

the longeron and held in place by screws with two ends bent up and held together to take turnbuckles or internal wires. Four other flaps, extending from the flaps on the inside of the longerons and turned up are used for fastening the other cross members. Details of the fittings used are shown in Fig. 7.

The body has a good stream-line form, more slender than it formerly was. The two lower wings are attached directly to level with the pilot's seat, and are narrowed together at a point 3 feet 3 inches behind the pilot's seat. The uprights and cross members are of pine.

The top of the body is covered with arched plates, which, like those of the hood, are made of aluminum. The rest of the body is covered with fabric. The floor of the cockpit is made of aluminum plates. There are folding steps inside, none outside.

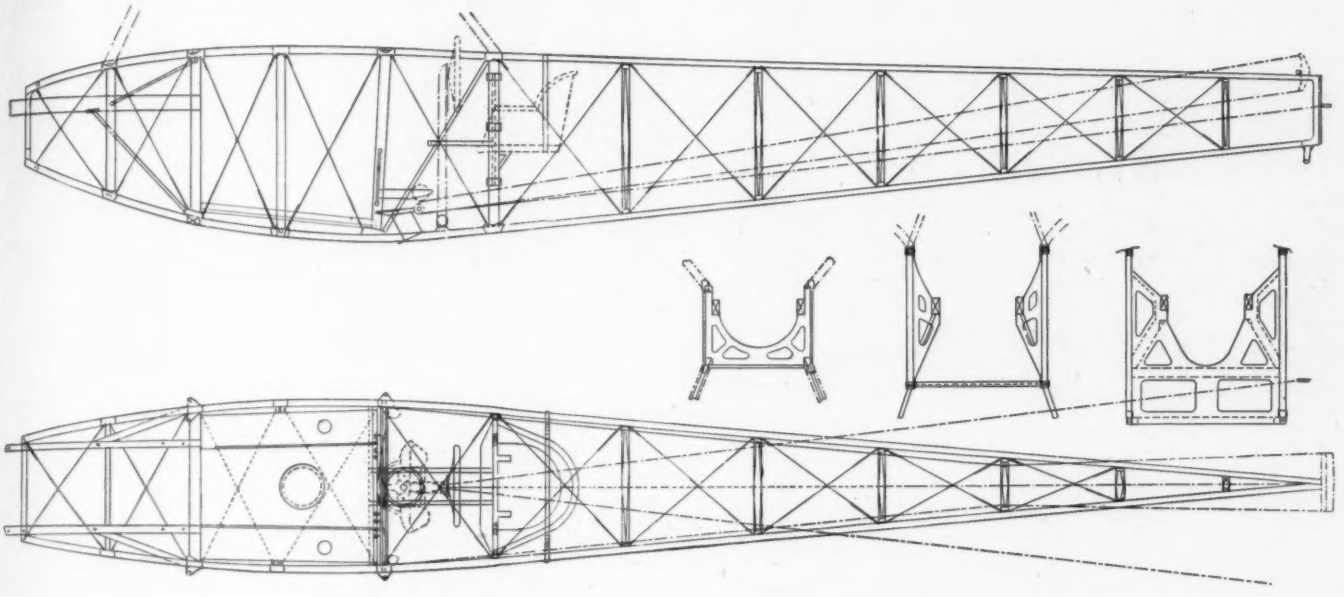

FIG. 5. PROFILE AND PLAN OF THE BODY OF THE TYPE OF AVIATIK NOW IN USE.

The main illustration shows steering column and rudder bar with control wires. The small diagrams show engine bed construction and supports.

the body on its sides and slightly above its lower edge. A hollow steel tube running through the body transversely, as shown in Fig. 6, is extended by a steel rod, *t*. This rod is passed inside the two rings, *a*, that are part of the metal fitting that envelops the end of the wing spar. A key of elbow shape, but movable from front to rear, locked by a spring, *r*, passes through the two holes, *a*, and a hole in end of *t*, and holds the wing securely to the body.

The two upper wings are assembled to one another in a similar manner on vertical tubes supported by the body. There is no open space between them.

The cock-pit is built of inclined steel tubing, with the two rear uprights slanted backward more than formerly, the object being to facilitate the working of the machine gun, which moves about in the cock-pit instead of at the back of it, as in the L.V.G. The top frame of the cock-pit is a round tube, and the four uprights are tubes of elliptic section.

Besides connecting the rudder and elevator with the wings and carrying the landing gear, the body holds the engine in front. A large part of the cylinders project outside of the hood.

Level with the wings and between the main gasoline tank the passenger sits on a folding seat (the two variable weights: passenger and fuel, being near the center of gravity, have little influence on longitudinal equilibrium). Although seated well inside the body behind the engine, so that his vision is certainly interfered with, the passenger is rather poorly protected from the wind. The pilot, however, is comfortably seated in a willow armchair with velvet upholstery. A little rectangular window enables him to see perpendicularly beneath the machine.

The body is made almost wholly of wood. As in all German biplanes, the four main longerons are of ash wrapped with fabric from the front of the machine to the back of the rear seat, and from there on of non-wrapped pine. The joints are beveled and wrapped. As in the L.V.G., and contrary to the Rumpler practice, the four longerons of the Aviatik retain their maximum thickness right up to the bow, where the bed for the engine is supported by two cross members, and between these cross members by a thin bracket on either side. The two upper longerons curve downward sharply at a point

LANDING GEAR

The landing gear has remained almost identically what it was prior to the war. It is composed of two Vs of elliptic tubing well spread outward, and with the two supporting members connected at the bottom by a round tube fitted with wooden stream-line members.

The landing gear is held in shape by a cross member of elliptic tubing, horizontal cables and steel cable cross stays.

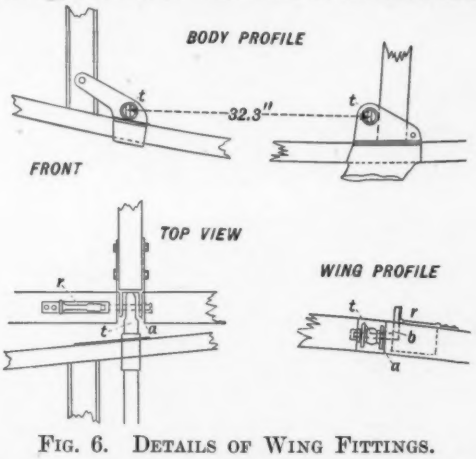

FIG. 6. DETAILS OF WING FITTINGS.

The axle rests inside of the points of the two Vs and is elastically attached to the cross section of which Fig. 8 shows the peculiar arrangement.

On recent Aviatiks, due to the lack of rubber, the landing gear is different. It has returned to the type usual in France and Germany, but the "Sandow" rubber cords are replaced by three long spiral springs set one inside of the other. ("Abfederungs-Kabel" shock-absorbing cable "taking the place of rubber.") The tread remains very broad, 6 feet 2.75 inches.

Most of the tubes in the Aviatik, notably the tubes of the landing gear, and of the struts, are internally reinforced with wood. This is not the case with other biplanes.

The tail-skid shown in Fig. 4 is of the type usually found on German airplanes. It is a rod of wood, all outside of the body, hinging on a pivot that is also outside of the body and is held in place by rubber rings that are inside of the body. It is attached underneath a complex piece of metal

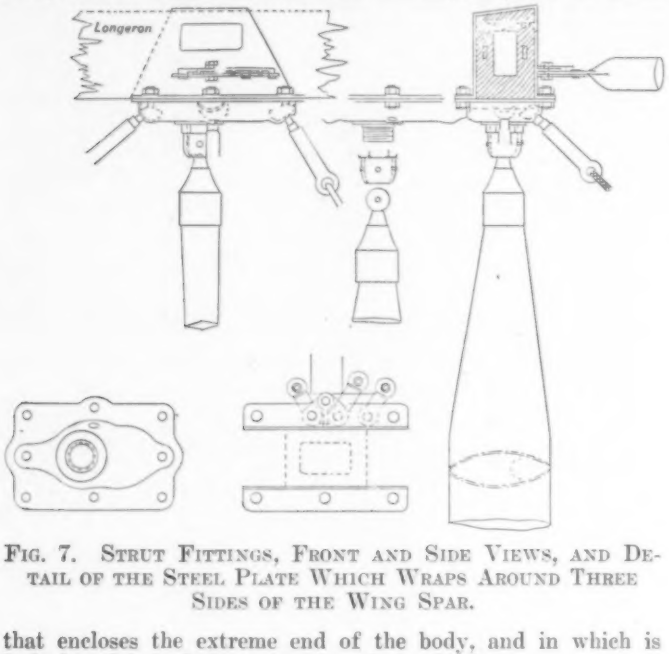

FIG. 7. STRUT FITTINGS, FRONT AND SIDE VIEWS, AND DETAIL OF THE STEEL PLATE WHICH WRAPS AROUND THREE SIDES OF THE WING SPAR.

that encloses the extreme end of the body, and in which is locked and bolted the extremity of the fixed fin.

CONTROLS

The Aviatik concern has adopted the Deperdussin type of control. As shown in Fig. 5, the aileron cables pass inside the lower wings, and the rudder is controlled by a foot-bar through cables. The rudder-bar has heel-rests made of metal tubes.

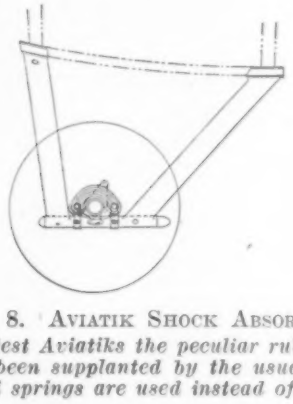

FIG. 8. AVIATIK SHOCK ABSORBER.

On the very latest Aviatiks the peculiar rubber arrangement here shown has been supplanted by the usual shock absorber except that spiral springs are used instead of rubber cord.

ARMAMENT

On the right and left, in front of the pilot, are two 8.46 inch bomb-launching tubes formed of sheeting. The launching trigger is provided with a spring and the passenger fires it by pulling a cable.

To the right of the passenger's seat, that is to say, between the wings, are arranged, on the outside and parallel to the upper edge of the body, two elliptic tubes, each supported by three brackets and reinforced by a curved tube at their rear end, for mounting machine guns. The middle bracket is recent and has been added to machines that were built before its adoption. A sort of sleeve slides on each of these tubes.

This sleeve is now split into two jaws to be able to pass over the center bracket. These jaws can be tightened and locked by a lever, *F*, shown in Fig. 9. They are of the "instantly-locking" type, in which by turning this lever from front to rear, the friction of its oblique-section, *A* against *B*, compresses the sleeve against the tube.

This arrangement, which is simple and little subject to derangement, makes it possible to fire while retreating. The gun can be fired in almost any direction to the rear of the vertical plane passing by the rear edges of the wings, and also forwards, except through the radius of the cone described by the propeller. This latter is protected by a circular guard.

However, though it is easy to move the machine-gun from the front to the rear and vice-versa, it is difficult to move it from the right support to the one on the left-hand side of the cock-pit; but normally the machines carry two machine-guns. As the support cannot be elevated when the gunner wants to fire upwards, he is obliged to fold his seat and get on his knees on the floor of the cock-pit.

On account of the arrangement of the engine and of the cock-pit, and especially because the passenger is seated in the front, the Aviatik does not lend itself, without important

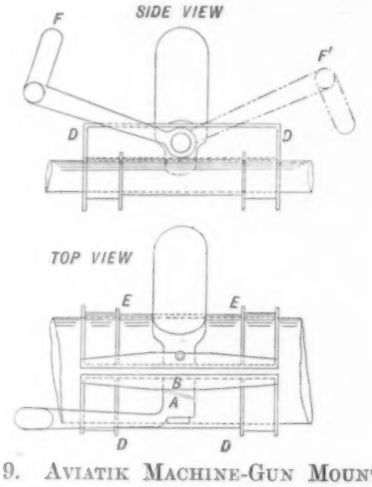

FIG. 9. AVIATIK MACHINE-GUN MOUNTING.

The jaws, D and E, separated to pass by the intermediate bracket, slide on an elliptic tube and are compressed and locked on it by the friction of A against B when the handle F is turned.

changes, to the adoption of the system that has become general on other German airplanes, namely, the use of a stationary machine-gun firing through the propeller for the pilot, and another gun on a rear fitting to be used by the passenger.

SUMMARY

The total weight of the Aviatik of 1916 is the same as that of the L.V.G. and about the same as that of the Rumpler.

Weight of the body (including radiator, tanks and pipe lines)	757 pounds	
Weight of the wings	308 "	
" " struts	28 "	
" " propeller	42 "	
" " engine	673 "	
" " cooling water	55 "	
Total weight empty		1,863 pounds
Weight of fuel	418 pounds	
Useful weight: pilot, passenger, armament, accessories, etc.	550 "	
Total load		968 pounds
Total		2,831 pounds
Weight per square foot of sustaining surface		6.81 pounds

SPEEDS	Test in France	From German Source
Maximum speed at sea-level	82 miles per hour	
Minimum " " "	49 " " "	
Speed at 1,000 meters	79 " " "	83 miles per hour
" " 2,000 "	74.5 " " "	80.7 " " "
" " 3,000 "	66 " " "	
Climb to height of 500 meters	4 minutes 30 seconds	
" " " " 1,000 "	9 " 30 "	
" " " " 2,000 "	21 " 30 "	
" " " " 3,000 "	47 " 30 "	

Supplies carried for 4 hours and 30 minutes flight.

The maximum climb of the machine is 3,500 meters, or nearly 11,500 feet, with a useful load of 720 pounds. German pilots have, however, affirmed that they have climbed as high as 15,750 feet with their observer and 18.5 gallons of gasoline.

Aviatiks with Benz and Mercédès motors of 220 horse-power, differing from the 170 horse-power in cylinder bore only, are said to be in building, with two machine-guns, one of which will fire through the propeller. They are expected to have a speed of 93 miles per hour at a hight of 2,000 meters.

The present type is handy; the working of its rudder and elevator is fairly good, and its motor is strong and flexible.

Agreement for Manufacturing Under Wright Patents

The following agreement has been sent out to manufacturers of airplanes by the Wright-Martin Aircraft Corporation. It states the terms under which the owners of the Wright patents are willing to license competitors to build under those patents.

AGREEMENT made this day of , 191 , between Wright-Martin Aircraft Corporation, a corporation of New York, hereinafter termed the "Licensor" and a corporation of , hereinafter termed the "Licensee."

WHEREAS, the Licensor is the owner of United States Letters Patent No. 821,393, issued on May 22, 1906, to Orville and Wilbur Wright, for Flying Machines, and the Licensee is desirous of obtaining a license thereunder.

NOW, THEREFORE, it is agreed as follows:

1. The Licensor grants to the Licensee a non-exclusive license to make, sell and use flying machines embodying the inventions described in said Letters Patent, together with parts thereof, throughout the United States and its territories and dependencies, and to make or sell such flying machines and parts thereof within the United States and its territories and dependencies for use or sale abroad.

2. The Licensee admits that said Letters Patent are good and valid in law and cover all types of heavier than air flying machines having one or more supporting planes in which it is possible to vary the lifting power of one wing in relation to the lifting power of the other wing through the medium of wing warping or by the use of one or more ailerons or by any other means.

3. The Licensor hereby releases the Licensee from all claims for past infringement of said patent.

4. In consideration of the foregoing license, the Licensee agrees that it will pay to the Licensor for the term of said license five per cent. (5%) of the gross receipts of the Licensee or any subsidiary or controlled selling corporation, received in connection with the manufacture, use or sale of said heavier than air flying machines, such gross receipts to include, among other things, all sums received for the sale of complete aeroplanes equipped with motors, or parts of aeroplanes, aeroplane engines, instruments used on aeroplanes, or other accessories, together with receipts from aviation exhibitions or aviation schools conducted by the Licensee, but it is particularly understood that if the Licensee shall sell areoplanes substantially complete except for the motor and motor accessories, the license fee for such aeroplanes only shall be ten per cent. (10%) of the gross receipts therefrom. It is further provided that from all such gross receipts there may be deducted the amount of any invoices for aeroplanes, engines, parts or accessories purchased from the Licensor. The Licensee further agrees that for the term of this license it will pay to the Licensor a minimum royalty at the rate of not less than Ten Thousand Dollars ($10,000) per year. Such minimum royalties shall be payable as provided in paragraphs 5 and 8 hereof.

5. To insure the payments of royalties hereunder, the Licensee agrees that on or before the first day of January of each year throughout the term of this license it will pay to the Licensor the minimum royalty above specified for the ensuing year (except that on January 1st, 1923, the sum shall be five-twelfths of such sum). Such minimum payment shall forthwith become the property of the Licensor, but in the event that the actual royalties upon the business in any year, based on the gross receipts of the Licensee in accordance with paragraph 4 hereof, are less than said sum of Ten Thousand Dollars ($10,000), the Licensee shall be credited with such difference, to be applied to the payment of future royalties, in the event that for the business in any year or years thereafter the royalties under this license are in excess of said minimum sum of Ten Thousand Dollars ($10,000).

The Licensee further agrees that on the 10th day of each April, July, October and January during the term of this license, it will render to the Licensor, sworn statements showing its gross receipts in the aeronautical business as defined in paragraph 3 hereof for the preceding quarter year. When any such statement shows that the royalties accrued for that portion of the calendar year for which the statement is rendered, are in excess of the minimum sum paid in advance for that year, the Licensee agrees that at the time it renders such statement to the Licensor it will pay to the Licensor the amount of such excess and that in rendering statements for the business done in the balance of that year it will pay the royalty accrued without any deduction.

6. The Licensee agrees to keep full and complete books of account concerning its aeronautical business as defined in paragraph 4 hereof, and to allow the duly accredited agent of the Licensor to inspect such books at all reasonable business hours.

7. The Licensee agrees that it will attach to each flying machine it sells under this license, a name plate bearing the Licensee's name, a serial number, and the statement "Licensed under U. S. Patent No. 821,393 of May 22, 1906."

8. This license shall remain in force until the 23rd day of May, 1923, but it is particularly provided that if the Licensee shall fail to pay the royalties provided for in paragraph 4 hereof, or to render the statements and make the payments provided for in paragraphs 4 and 5 hereof, the Licensor shall have the option (a) of cancelling this license by giving the Licensee 30 days' notice in writing of its intention so to do, unless the breach complained of is remedied within said 30 day period, or (b) of electing that the minimum royalties provided for hereunder for all of the remaining years of the license are forthwith due and payable to the Licensor without discount. The election by the Licensor of either of the foregoing remedies shall not deprive the Licensor of the right to recover any sums due under this agreement.

9. Upon the termination of this license for any cause the Licensee agrees to make to the Licensor a sworn statement such as is provided for in paragraph 4 hereof, which shall not only include the gross receipts for the Licensee's aeronautical business, but likewise an inventory of all complete or partially completed articles, which if they had been sold would have been the basis for royalty under this agreement, and the Licensee agrees to pay royalty on the market value of all such complete or partially completed articles.

10. Nothing in this license shall be construed as granting to the Licensee any rights under any other patent owned or controlled by the Licensor, and the Licensee particularly agrees that it will not use the name "Wright" in connection with flying machines.

11. The Licensor agrees that if it grants licenses on terms other than those upon which this license is granted (except for the terms on which releases are granted for claims for past infringment), it will notify the Licensee and permit it, at its option, to accept such other form of license in place of this one.

12. This agreement shall be binding upon and enure to the benefit of the parties hereto and their successors, legal representatives and assigns, but the license herein granted shall not be divisible and shall be assignable only with the entire business and good will of the Licensee.

IN WITNESS WHEREOF the parties have caused this instrument to be executed by their officers thereunto duly authorized.

Body Construction

In an article recently published in *Flight*, some interesting suggestions regarding body construction and design are brought out. Considering first the standard girder body with the customary four longerons or rails, a comparison is made between the two methods in vogue, tapering from the back seat to the stern post and spindling.

Tapering involves considerable complication in the different fittings, for the varying sizes of cross struts and cross members that are usually employed. If with the same overall dimensions spindling is resorted to, the rails are left solid at the point of attachment, and the spindling process is complicated through having to lift the rails at these points. In either case, erecting and turning up is a serious problem, involving an expense perhaps almost as great as that of manufacture. Furthermore, in every type of girder body the danger from projectiles is very great. On these grounds attention to monocoque design is advocated.

In the Bleriot monocoque, a composition made of paper, pulp, silk and glue was used, and is said to have proved satisfactory aerodynamically and constructionally, but was too expensive. The Deperdussin monocoque, with a shell one-eighth inch thick, consisted of three thin layers of tulip wood, each layer forming an angle with adjoining strips, and no two joints coming immediately over one another. Excellent from the point of view of head resistance, strength and bullet worthiness, the Deperdussin, too, gave a complicated form of construction.

The writer insists particularly, however, on the advantage of trying metal monocoque construction. In lieu of three-ply wood of .15-inch thickness, it is computed that a steel shell of .013-inch thickness could be used for the same weight, although experimentation might suggest a heavier gage. For a 3-foot diameter body such a steel shell could be simply stamped and bolted, or riveted, and would, according to the author, give better results with projectiles.

A Method of Aligning Single-Engined Tractor Biplanes

By Byron Q. Jones, U. S. A.

The proper alignment of a machine largely determines the flying qualities of that machine.

The alignment of the body should be done at the factory or in the repair shop, and is not dealt with here.

The order in which the different parts of a machine should be aligned is as follows:

1. Alignment of landing gear.
2. Alignment of center section.
3. Alignment of leading edge.
4. Getting both wings the same height.
5. Dihedral angle, if any.
6. Alignment of trailing edge.
7. Droop.
8. Tightening and safetying all wires.
9. Length of struts, positions of fittings, warp in planes.
10. Alignment of ailerons.
11. Alignment of stabilizer.
12. Alignment of elevator flaps.
13. Alignment of rudder.

The tail of the machine should be raised until the body is nearly horizontal before starting the alignment.

ALIGNMENT OF LANDING GEAR

When a machine is being assembled, it is easier to align the landing gear before the wings are put on. Take the weight off the landing gear by supporting the body on sawhorses. The axle should be parallel with the lateral axis of the machine. The center of the axle should be directly under the center of the body.

(*a*) By measuring cross distances: Loosen and tighten the cross wires until the cross distances are exactly the same. Take all measurements from similar points on the fittings to which the wires are attached.

(*b*) With level and plumb bob: Level the body crosswise. Mark the exact center of the body and drop a plumb bob. Mark the exact center of the axle. Adjust the cross wires until the plumb bob is over the center of the axle. Tighten the wires until fairly tight, and safety them.

ALIGNMENT OF THE CENTER SECTION

When assembling the machine the center section should be aligned before the wings are put on. When a machine is already assembled, the first thing to do is to loosen all wires except the landing wires. This is very important, for if one wire is tightened against another wire an unnecessary and possibly a dangerous strain may be put upon some member.

(*a*) Machines having no stagger:—In machines having no stagger, the struts of the center section should be perpendicular to the propeller axis. As the upper longerons are usually parallel to the propeller axis, they may be used as a base line.

Align one side of the center section first, then the other side, and lastly the front. From a point at the lower end of one of the front center section struts, the center of a bolt head for example, measure forward on the longerons a certain distance. From the same point (center of bolt head) measure back on the longeron exactly the same distance. Move the upper end of the strut forward or backward by loosening one of the cross wires and tightening the other, until the distance from the two points on the longerons to some point at the top of the strut (center of bolt head) are exactly the same. The strut will then be perpendicular to the propeller axis. Tighten both wires evenly until fairly tight.

Measure the cross distances (the diagonal distances between similar points at the upper and lower ends of the front and rear struts), and align the other side of the center section until its cross distances are the same as those on the opposite side. Align the front of the center section by loosening one cross wire and tightening the other, until one cross distance is exactly the same as the other cross distance.

(*b*) Machines having stagger:—In machines having stagger the shape and position of the center section strut fittings usually determine the amount of stagger the machine was designed to have. Adjust the cross wires on one side of the center section until the struts on that side are in their correct positions as shown by the shape of the fittings. Tighten the wires, measure the cross distances, and adjust the wires on the other side of the center section until the cross distances are exactly similar. Next, adjust the two front wires until one cross distance is exactly the same as the other cross distance.

ALIGNMENT OF LEADING EDGE

(*a*) Upper plane:—The leading edges of the upper and lower planes of one wing should next be made perfectly straight. By standing on a step-ladder, placed 15 or 20 feet to one side, and sighting along the leading edge of the upper plane, any bow or warp can easily be seen. This should be straightened out by loosening or tightening the front landing wires. The edge should be brought in exact line with the leading edge of the center section.

(*b*) Lower plane:—After the leading edge of the upper plane has been made straight, sight along the leading edge of the lower plane. If there is no warp in the plane, this edge should also be straight.

(*c*) Align the opposite wing in the same manner.

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A French Biplane Being Assembled.

GETTING BOTH WINGS THE SAME HEIGHT

Place a small tack exactly in the middle of the leading edge of the center plane. Measure from this tack to similar points at the lower ends of the intermediate and outer struts. Make these distances the same on each side by raising or lowering one wing or the other, or by raising one wing and lowering the other wing; all the while keeping the leading edges of both wings perfectly straight.

DIHEDRAL

The method of setting the wings of a machine at a dihedral angle is as follows: Place two tacks in the leading edge of the upper plane, one tack near the tip of each wing and exactly the same distance out from the tack in the center section. Stretch a string tightly between the two outer tacks, until there is no sag in the string.

A dihedral angle is any angle over 90 degrees and under 180 degrees.

A dihedral angle of 178 degrees means that each wing has been raised one degree. To set the wing of a machine at a dihedral angle of 178 degrees, for example:

(*a*) Find the natural sine of one degree.

(*b*) Multiply this by the distance in inches between the center tack and one of the outer tacks. The result will give rise, in inches, of the string over the tack in the center section.

Raise the wings equally, keeping the leading edges perfectly straight, until the proper rise shows over the center section. Attention is here called to the fact that as the wings are raised the landing wires become shorter while the flying wires become longer. This is due to the fact that bays are changing from rectangles to rhomboids.

ALIGNMENT OF TRAILING EDGE

(*a*) Lower plane:—The trailing edge should be brought parallel to the leading edge. This can be done by bringing the rear spar in line with the leading edge. Stand squarely in front of the center of the machine, 15 or 20 feet away. Sight under the leading edge of the lower plane; move forward or backward until the fittings under the rear spar are just visible. Raise or lower the trailing edge by loosening or

tightening the rear landing wires, until all of the fittings on the rear spar appear equally under the leading edge.

(*b*) Upper plane:—After aligning the trailing edge of the lower plane, place a ladder in front of the center of the machine, and sight under the leading edge of the upper plane. If there is no warp in this plane, the trailing edge should align with the leading edge. The trailing edges of both wings should be aligned before any droop is given.

DROOP

To correct for the torque of the propeller, one wing of a machine is slightly drooped. In single motored tractor types, if the propeller turns to the right, when looking from the rear, the left wing is drooped, and vice versa. The outer rear landing wire of the wing to be drooped should be loosened until the trailing edge, between the outer and intermediate struts, appears to be about an inch (for machines of not more than 100 horsepower) lower than the rest of the trailing edge.

TIGHTENING AND SAFETYING ALL WIRES

(*a*) After the wing is drooped, all flying wires should be tightened to the same tension, and just taut enough to take out all sag.

(*b*) Next tighten all drift or cross wires between the front and rear struts to the same tension.

(*c*) Drift wires from the wings to the body, and from the wings to the landing gear, if any, should be tightened last.

(*d*) Safety all turnbuckles.

A wire too loose will vibrate when the machine is in the air. The flying and drift wires should be so tightened that when they take the weight of the machine in the air there will be no sag in the landing wires.

LENGTH OF STRUTS, POSITIONS OF FITTINGS, WARP IN PLANES

The above instructions are given for machines that are true, that is, machines having no bends, warps, or bows in the spars and leading or trailing edges.

(*a*) Similar struts should be of the same length.

(*b*) Similar fittings occupying similar positions should be spaced the same. If difficulties are encountered in getting the measurements to tally, check up the length of the struts and the positions of the fittings.

(*c*) If the planes of a machine are warped, the machine should be so aligned that the warp is equally divided between both planes.

ALIGNMENT OF AILERONS

Before aligning ailerons place the shoulder yoke or wheel controlling the ailerons in the center of its path of movement.

(*a*) Trailing edge ailerons:—Trailing edge ailerons should be set to line up with the trailing edge of the plane to which they are attached.

(*b*) Inter-plane ailerons:—Inter-plane ailerons should be set so that they are both in the same plane when in neutral position. In machines having inter-plane ailerons, nose heaviness and tail heaviness may be corrected by setting the trailing edges of the ailerons up or down. The proper amount to raise or lower the trailing edges can only be determined by experimenting with each particular type of machine.

(*c*) The control wires should be just tight enough to eliminate any lost motion.

ALIGNMENT OF STABILIZER

Support the weight of the tail on the tail skid. The rear edge of the stabilizer should be perfectly straight, and should be parallel with the lateral axis of the machine. Stand behind the center of the stabilizer and align its rear edge on the leading edge of the upper plane by sighting. Tighten wires and safety turnbuckles.

ALIGNMENT OF ELEVATOR FLAPS

Set the elevator control in its mid-position. Adjust the elevator control wires until the flaps are in their neutral position and both are in the same plane. The wires should be just tight enough to eliminate any lost motion. Safety turnbuckles.

ALIGNMENT OF RUDDER

Set the rudder control (wheel, foot pedals, or foot bar) in its mid position, either for gliding or power flight, as desired. Adjust the rudder control wires until the rudder is in its neutral position. The control wires should be just tight enough to eliminate any lost motion. Safety the turnbuckles.

It will be noted that in the alignment of the center section, the method of determining stagger is not given where the center section and wing fittings are such as to permit of varying degrees of stagger, as this is simply a case of angles and can be easily computed. In aligning the leading edges, it was taken that the leading edge of the upper plane should be aligned first. This really only holds true where the person doing the aligning does not have to adjust the wires himself; that is, if he can stand off, do the sighting and give directions. It is, on the whole, preferable to align the leading edge of the lower plane first and upper plane second. A. K.

Secretary Daniels Outlines Naval Air Policy

Secretary of the Navy Daniels has written to AVIATION AND AERONAUTICAL ENGINEERING the following letter telling the Navy's policy in regard to the upbuilding of the aeronautical branch of the service:

NAVY DEPARTMENT, WASHINGTON, D. C.

Sir:

I beg to acknowledge receipt of your letter requesting a statement in regard to the policy of development of aeronautics in the Navy, and the method of training officers and men of, and connected with, the Naval Service.

The policy is to develop seaplanes, dirigibles, and any other form of aircraft which may be useful, to a state where they will be of great assistance to the Fleet in the many problems with which it has to contend or representing the first line of defense of the nation.

It is anticipated that the following duties will be performed by naval aircraft:

(*a*) Scouting from ships at sea.
(*b*) Off shore scouting from coastal stations.
(*c*) Spotting.
(*d*) Offensive operations against enemy aircraft and possibly against ships and stations.

Of the duties enumerated it is considered that scouting is primary, and it is the endeavor of the Navy to develop aircraft for this purpose. Seaplane development has been carried on for several years, but has a long way to go before most of the required military conditions to make them a very useful adjunct are fulfilled. The conditions are much harder than for land machines; *i. e.*, weights and head resistance are greater, difficulties of float construction are enormous, method of handling necessitates special construction, and additional engine power is required to break machine from water. The solution of the seaplane problem is difficult because so few people really understand the many difficulties encountered. A certain amount of co-educational work was therefore necessary before any real progress could be made. Development of lighter-than-air craft is equally slow, as most of this work has been done abroad, and the knowledge on the subject in this country is very limited.

Now that sufficient funds have been appropriated the Navy is in a position to push the development of this type of aircraft, and it is hoped that immediate results will be forthcoming. Specifications for lighter-than-air craft will be sent out before January 1, 1917.

The training of personnel has been slow, because of the lack of proper seaplanes with which to carry on the training. The system is thoroughly organized, and satisfactory seaplanes for this purpose are now being produced. The Aeronautic Station at Pensacola has been greatly developed, and the school at that place is working to the limit of its present capacity. In addition to training regular classes of Naval and Marine officers and men, classes of Naval Militia and Coast Guard officers and men are now received every three months and put through the course. In this way the trained personnel available in time of war is being rapidly increased. It is the intention to establish other stations as rapidly as the development of the air service will warrant.

The *U. S. S. Seattle*, equipped with five seaplanes and catapult launching device, will go South with the Destroyer Force for the winter practice in the Carribean. The *U. S. S. North Carolina will* again go to sea after her repairs are completed. She is also equipped with seaplanes and catapult launching device. Specifications for a special type of seaplane for use from ships at sea have been sent to the various seaplane manufacturers throughout the country and it is hoped that by next spring some of this type will be ready for use.

In conclusion, it can be said that the training of personnel is now progressing smoothly, and that efforts are being made in every direction, both in America and abroad to obtain material for the proper equipment of the Navy.

JOSEPHUS DANIELS, *Secretary of the Navy.*

Course in Aerodynamics and Airplane Design*

By Alexander Klemin, A.C.G.I., B.Sc., S.M.

Instructor in Aeronautics, Massachusetts Institute of Technology, Member of the Aeronautical Society of Great Britain and Ireland

and

T. H. Huff, S.B.

Instructor in Aeronautics, Massachusetts Institute of Technology.

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PART 1—SECTION 11

Resistance and Comparative Merits of Airplane Struts

Considerations of Comparative Merit of Strut Sections

It is naturally desirable that some single expression be found which will give the general efficiency and theoretical desirability of any strut section under consideration. This was first done by the staff of the National Physical Laboratory, who devised what they called the "equivalent weight," and we have here employed an adaptation of this quantity under the name of the "merit factor." In deriving this, we start with the basic assumptions that the speed of the machine is 60 miles per hour, the gliding angle 1 in 7, and the average width of the struts about 1 inch (the exact breadth assumed depending on the form and strength of the section).

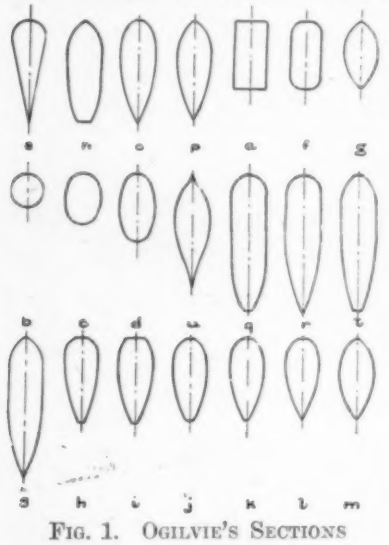


FIG. 1. OGILVIE'S SECTIONS

Then, since gliding angle $= \frac{W}{R}$, every 7 pounds of strut weight will give rise to 1 pound of resistance, in addition to the aerodynamic resistance of the struts.† We can, therefore, write $T = \frac{W}{7} + R$, where T = thrust due to the struts, and R is their aerodynamic resistance. Simplifying, we have $C = W + 7R$, but, since this expression has a maximum value for the least efficient strut, the reciprocal is here employed, and multiplied by the constant 14300, giving $C = \frac{14300}{W + 7R}$.

The best strut under the conditions above specified is then the one showing the highest value for C. The reason for choosing this particular value for the multiplier is that it makes $C = 100$ for the best strut of the first and largest series which we shall consider.

If the speed of the machine for which the struts are being selected is greater than 60 miles an hour, the resistance becomes of greater importance as compared with the weight, and the merit factors for those sections which, although heavy, offer very low resistances are relatively improved. If the gliding angle is flatter than 1 in 7, a similar effect ensues.

On the other hand, if it becomes necessary to use struts having a diameter of more than 1 inch or thereabouts, the advantage inclines toward the sections which have the greatest strength for their weight, and the relative importance of resistance is diminished, since, in similar sections, weight varies as the square of the breadth and resistance only as the first power. These effects are, however, of slight importance, and would not be likely to change the merit factors enough to have serious influence on the choice of a section in any given case.

The question of strength will be taken up more fully in another section of the course. It will suffice to say here that the strengths of two struts have been considered to be equal when their moments of inertia about their longitudinal axes are equal.

Strut Sections Developed by Ogilvie

We may now proceed to the examination of definite data for a number of series of struts, tested at various times and places. The following figures are the result of experiments performed at the N. P. L. at the suggestion of Alec Ogilvie, the sections being illustrated in Fig. 1.

I = moment of inertia for the section in question about its longitudinal axis (inches⁴ for a strut 1 inch wide).

R = resistance in pounds of 100 feet of strut 1 inch wide at 60 miles per hour.

W = weight in pounds of 100 feet of spruce strut 1 inch wide.

b = width of strut whose strength will be equal to that of a strut of section a, and 1 inch wide.

W' = weight of 100 feet of spruce strut of width b.

C_{60} = merit factor at 60 miles per hour.

No.	I	R	W	b	W'	C_{60}
a	.167	104.4	41.6	1.00	41.6	19
b	.049	81.9	16.4	1.36	30.3	18
c	.090	59.2	30.4	1.17	41.6	27
d	.124	36.9	34.8	1.08	40.6	45
e	.074	63.0	33.4	1.23	50.6	24
f	.134	28.6	37.7	1.06	42.4	56
g	.094	54.9	30.0	1.15	39.7	30
h	.119	12.8	39.7	1.09	47.1	99
i	.127	12.8	41.0	1.07	47.0	100
j	.119	13.5	39.7	1.09	47.1	96
k	.111	13.5	38.0	1.11	46.8	94
l	.106	29.9	36.4	1.12	45.6	51
m	.106	45.9	36.6	1.12	45.9	35
n	.171	14.2	51.9	0.99	50.9	97
o	.146	13.5	47.0	1.03	49.9	97
p	.128	18.7	44.1	1.07	50.5	75
q	.245	15.1	71.0	0.91	58.9	93
r	.227	16.4	67.2	0.93	58.1	87
s	.194	13.5	62.0	0.96	57.2	97
t	.209	13.5	66.1	0.95	59.7	95
u	.115	24.6	42.5	1.10	51.4	59

Many very interesting conclusions can be drawn from this table. In the first place, it is evidently of the utmost importance to avoid rapid changes in curvature. Several sections, notably, *e* and *l*, although they appear to have a very smooth outline, oppose a large resistance simply because the transition from the entrance to the run is so abrupt that the air-flow cannot follow its contour, and violent eddy-making ensues.

The good performance of several sections so formed indicates that it may be wise actually to run the sides of the strut parallel for some little distance, as illustrated by *q* and *t*. This is counteracted, however, by the fact that skin-friction increases in proportion to the "wetted surface" of the strut. It is for this reason that the very longest sections did not give such low resistances as those of more moderate form. This matter of the ratio of length of section to width will be discussed more fully somewhat later, in connection with another series of tests.

It will be seen, too, that the resistance is little affected by the chopping off of a portion of the tail in such a manner as to leave it straight across. Examples of this are furnished by *n*, *t* and *i*. This is due to the fact that it has not been possible in any strut yet designed to totally eliminate the region of deadwater behind the strut. As will be evident from any section of air-flow about a fair-shaped section, the lines of flow always leave the contour of the strut some distance short of the extreme rear. Since no changes made in the contour within this region will have any decided effect on the re-

* This Course commenced in the August 1, 1916 issue of AVIATION AND AERONAUTICAL ENGINEERING, will be completed in 24 issues. It will embody the fundamental aeronautical data necessary for airplane design, and present the design of standard machines in complete, simple and systematic form.

† Relationships between weight and resistance on a glide will be fully considered in Section 12.

sistance, it avails nothing to go to the trouble and expense involved in the attempt to construct a wooden strut running out to a sharp point at the back.

Another Series of Struts Tested at the N. P. L.

At about this same time another series of struts was tested at the same laboratory, the sections being those actually em-

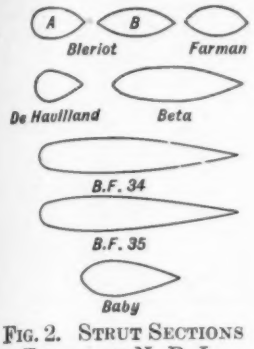


FIG. 2. STRUT SECTIONS TESTED AT N. P. L.

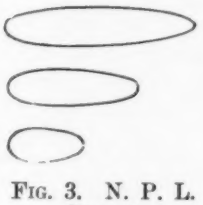


FIG. 3. N. P. L. STRUTS

ployed in machines then existing. The outlines of the sections tested are shown in Fig. 2, and the characteristics are given below.

Name.	I	R	W	b	W'	C_{60}
Bleriot A....	.070	51.0	26.0	1.24	40.0	30
Bleriot B....	.107	52.7	34.9	1.12	43.8	31
Farman	.074	49.3	25.2	1.22	37.5	31
De Havilland.	.052	54.9	20.5	1.34	36.8	26
Baby	.110	17.0	41.6	1.11	51.5	78
B.F. 34.....	.279	15.5	93.2	0.88	72.0	85
B.F. 35.....	.238	13.5	89.7	0.92	76.0	88
Beta	.188	14.8	61.7	0.97	58.0	90

It will be seen that these figures simply supplement and

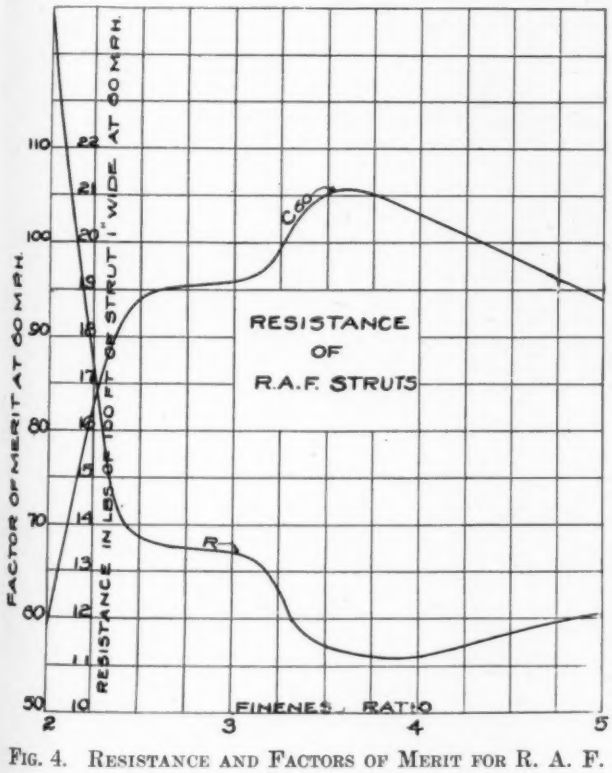


FIG. 4. RESISTANCE AND FACTORS OF MERIT FOR R. A. F. STRUTS

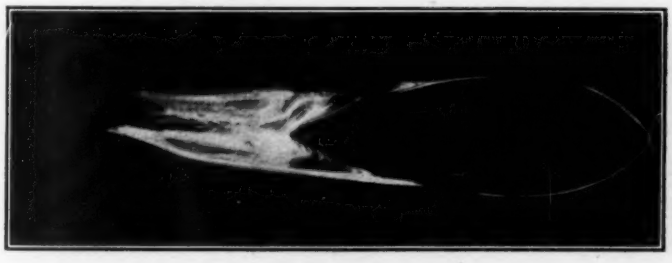
confirm the conclusions already deduced from the more extensive and systematic investigations directed by Mr. Ogilvie.

Tests on Struts, Length to Width Varied

As a result of these and other tests, a series of struts embodying the best features of those already tried, and varying only in the ratio of length of section to width, was made and tested at the National Physical Laboratory. Three representative members of this series are shown in Fig. 3. The table below gives the characteristics of these struts, the meaning of the symbols being the same as in the tables already given, except that n = the ratio of the length to width of section.

n	I	R	W	b	W'	C_{60}
2.	.094	24.8	32.0	1.15	42.3	59
2.5	.117	13.7	40.0	1.09	47.5	94
3.	.141	13.4	48.1	1.04	52.1	96
3.5	.164	11.4	56.1	1.00	56.1	105
4.	.188	11.2	64.1	0.97	62.2	103
4.5	.211	11.7	72.1	0.94	67.8	99
5.	.235	12.1	80.1	0.92	73.7	94

Thus it is apparent that the best of these sections are materially superior to the best of the sections tested by Ogilvie, both in resistance and in merit factor. In Fig. 4 resistance of



BABY

BETA

DE HAVILLAND

FIG. 5. ILLUSTRATING FLOW AROUND STRUTS

100 feet of strut at 60 miles per hour, and merit factor at 60 miles per hour, are plotted against ratio of length to width. As this ratio diminishes, the air-flow about the strut takes on a very uncertain character, and the values when n is less than 2 are rather doubtful. Such extremely short sections as this are also undesirable from the standpoint of lateral stability, as will be shown in another section of the Course. On the other hand, n may be considerably greater than the absolute optimum value without any great disadvantage, so it will be well in general to employ a ratio of four, or even a slightly higher figure. The photographs of flow about strut sections, reproduced in Fig. 5, show clearly why such a procedure can be safely adopted.

Two Eiffel Struts

Two struts of somewhat the same section as those just discussed have recently been tested by Eiffel, and show remarkably low resistances. Their outlines are given in Fig. 6. For No. 1, having n equal to 3.23, R equals 9.7 pounds, while for No. 2, with a somewhat sharper entry, n is 2.96 and R is only 8.7 pounds. Part of this improvement over the best of the English tests, however, is undoubtedly due to the higher wind speed which is secured in Eiffel's laboratory, the resistance coefficient having a tendency to rise as the speed of test is decreased.

Effect of Length of Struts

We now turn our attention to the effect of the length of the strut. While this point is less important than was generally supposed a few years ago, and while its effects are largely determined by the nature of the surfaces in which the strut terminates, the experimental results bearing on the matter should nevertheless be studied. For this data we are indebted to Mr. Thurston, who has described his results in the series of articles already cited. As the result of a great many experiments on manifold different types of strut, he

FIG. 6. TWO EIFFEL STRUTS

came to the conclusion that resistance for a strut with free ends could best be expressed by the formula $R = KltV^2 - .0073t^3V^2$, where R is the resistance in pounds, l and t, respectively, the length and thickness of the strut in feet, K a constant, and V the speed in miles per hour.

It is evident from this equation that, even with the lowest values of K yet obtained, the effects of length will be practically negligible when the length is more than 50 times the thickness, as it generally is. Since, in addition, the case of a strut with free ends is one which never occurs in practise, resistance may be considered as independent of length-thickness ratio for all the purposes of design.

The form of air-flow about the wing may have very decided effects on the resistance of interplane struts, but we have no means of knowing how great these are, and experiments covering this point and susceptible of performance in a wind tunnel would be exceedingly difficult to devise. The matter might well be investigated in an outdoor, full-scale plant such as that at St. Cyr.

Resistance of Inclined Struts

The only point which remains to be studied is the resistance of struts which are not normal to the line of flight. Some much more recent tests by Mr. Thurston have covered this point, and show very surprising results. Struts of square,

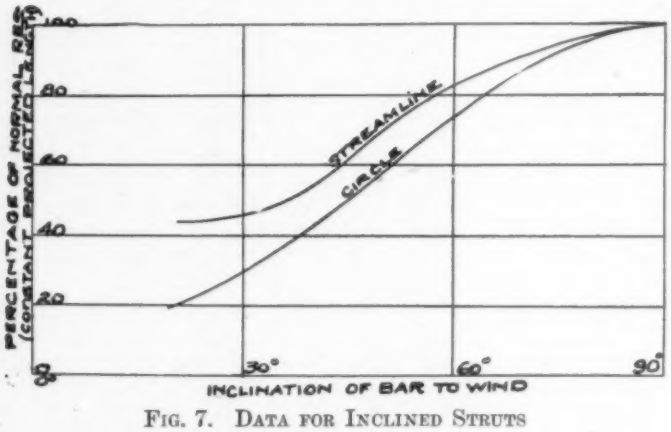


FIG. 7. DATA FOR INCLINED STRUTS

rectangular, circular, and stream-line section were tested at angles from 0 to 90 degrees, and the effects of the ends of the strut offering a direct resistance when inclined were overcome by the use of the method of differences: that is, tests were made first on a strut 34 inches long, and then on one 16 inches long, the difference of the figures obtained being equal to the resistance of an 18-inch section of an infinite strut.

The ratio of the resistance of a strut inclined at various angles to the resistance of a normal strut of like section and equal projected length is plotted in Fig. 7. It will be seen that the resistance at 30 degrees to the wind is less than one-third of that at 90 degrees, and this large difference is by no means accounted for by the difference in length of section parallel to the wind. When a circular strut is placed at an angle of 30 degrees to the wind, the section parallel thereto is an ellipse having a length of twice its width, and the resistance of an elliptical strut such as this, when placed normal, is only 36 per cent less than that for a circular section. About 45 per cent of the reduction due to inclination thus remains unaccounted for.

Since, however, the curve of reduction is substantially a sine curve, and is therefore very flat at the ends, there is very little advantage to be gained from inclining a stream-line strut unless it is inclined at least 30 degrees to the normal. This reduced resistance should, however, be kept in mind as a point in favor of the staggered biplane. Eiffel also made a few tests on struts inclined 30 degrees from the normal, the results checking very well with Mr. Thurston's.

The Effect of Changing the DV Product for Struts

As was shown in Section 10 of the Course, the resistance coefficient is not an absolute constant, but is a function of VD, where V is the speed and D the diameter of the strut. The coefficient tends to decrease as VD increases, but the change for values of VD (in foot/second units) above 6 is extremely small, as Eiffel has demonstrated. The tests made at the National Physical Laboratory have been made with a value of VD equal to only 2.5, whereas, in an actual machine, this quantity would never be likely to fall below 5, and is generally from 7 to 10.

We can therefore deduce from Eiffel's experiments that it is safe to reduce the values for resistance here given (for the N. P. L. tests) by about 25 per cent in applying them to a design. This indicates that, as was hinted above, the superiority of Eiffel's strut sections is more apparent than real, and that the best sections yet available are the N. P. L. sections having fineness ratios of from 3.5 to 4.5. The correction given here should be applied only to struts of fairly good section, as the value of VD has much less effect on those sections for which the resistance is relatively high, and in which there is more effect due to turbulence than to skin friction.

References for Section 11

Struts, *Flight*, June 15, 1912.
Aerodynamic Resistance of Struts, Bars, and Wires, by A. P. Thurston; *Aeronautical Journal*, April and July, 1912.
Technical Reports of the British Advisory Committee on Aeronautics, 1911-12, 1912-13.
The Resistance of Inclined Struts in a Uniform Air Current, by A. P. Thurston and N. Tonnstein, *Aeronautical Journal*, January, 1915.
Nouvelles Recherches sur la Résistance de l'Air et l'Aviation, by G. Eiffel. (1914 edition.)

Aeronautical Patents

Copies of these patents may be obtained for five cents each by addressing the "Commissioner of Patents, Washington, D. C."

ISSUED DECEMBER 12, 1916.

1,207,934. Filed March 28, 1914. To Augustus Peter Koch, New York, N. Y. A combination airplane and dirigible balloon.

1,208,259. Filed June 4, 1914. To Alexander Winton, assignor to The Winton Gas Engine and Manufacturing Company, Cleveland, Ohio. An apparatus for automatically controlling the feeding of liquid fuel to internal combustion engines.

1,208,337. Filed July 21, 1914. To Curt Leinweber and Fred. H. Leinweber, executors of Herman Leinweber, deceased. An airplane.

1,208,395. Filed June 11, 1910. To Ruter W. Springer, U. S. Army. An airplane having a plurality of supporting surfaces capable of being rotated about a lateral axis.

1,208,684. Filed April 20, 1906, renewed September 22, 1916. To Ruter W. Springer, Springfield, Ill. A soaring airplane.

ISSUED DECEMBER 19, 1916.

1,209,301. Filed March 21, 1916. To Henry Jander, Brooklyn, N. Y. A lighter-than-air turbine driven airship.

1,208,969. Original application filed July 2, 1909, Serial Number 505,735. Divided and this application filed March 29, 1912. To Russell Huff, Detroit, Mich., assignor by mesne assignments to Packard Motor Car Company, a corporation of Michigan. An improved type of sleeve valve for internal combustion engines.

1,208,984. Filed June 28, 1913. To James Kreiter, Fredericksburg, Ohio. A flying machine.

1,209,426. Continuation of Application Serial No. 692,269, filed April 22, 1912. This application filed April 15, 1916. To Hyman Eli Goldberg, Chicago, Ill. An airplane with the total mass with large moment of inertia to counteract moments of angular displacement.

Herbert Chase Joins Society of Automobile Engineers

Herbert Chase, who has been connected with the Automobile Club of America for several years as laboratory engineer and chief engineer, has joined the office staff of the Society of Automobile Engineers in the capacity of assistant secretary. Mr. Chase is Treasurer of the Society and a member of its Council.

Committee Hearings on Naval Aeronautics

Some interesting sidelights were thrown upon the aeronautical problems confronting the United States Navy at the recent hearings before the House of Representatives Committee on Naval Affairs.

Admiral Benson, Chief of Operations of the Navy, outlined the situation concisely in response to a question put by the chairman of the committee, Hon. Lemuel E. Padgett. He said:

"I can tell you in a few words about the aviation. We have been going on trying to get machines from all of the different makers in the country that had anything to offer. We have ordered machines from all of them. One of the principal troubles has been with the motors. We have tried all of the various makers, and we have given their engines or motors a try. We have finally, within the last two months, ordered 30 machines from the Curtiss Company, and the trials we have made with them have been very satisfactory, and we hope to get very good school machines and fairly good service machines, that we can operate between two and three hours; and the greatest difficulty with us has been with the motor. That is gradually being remedied."

Mr. BROWNING. "How long do you want it to stay in the air?"

Admiral BENSON. "We ought to have it stay up at least four to five hours for our purposes. The question of aviation is a very much mixed one, I think, in most everybody's mind, because in the Navy we only need aviation for two purposes: First, for scouting, to get information from the enemy, when we want it to act in conjunction with the fleet; and the other is to spot the fall of the shot in a battle. Now, it is the easiest thing in the world—we might get a thousand or more than a thousand aircraft, if we just wanted them to light on the land and fly over the land, but we, in the Navy, only want them for two purposes, and we want to concentrate all our energies and everything along those lines, to keep on until we have found what we want, and we have been experimenting with a catapult—an arrangement that fires the aircraft off the deck of the ship, because if you do not—if you are on the water, it is almost impossible for aircraft to get off the water, if there is any sea on; if it is at all rough you can not do it, because the machine dives head into the sea that is swirling over it, and it is destroyed; but if it can be fired from the deck of a ship, and go out into the air, as we are doing now from the *North Carolina*, and we hope in a few days from the *Washington*, and later from the *West Virginia*—if —he can go out and fly at the rate of a hundred miles per hour for possibly five hours he can come back, or send the information back by radio to the ships in regard to the enemy. This is the primary use for which the Navy wants aircraft; and the next thing is in battle for spotting the fall of the shot.

"Landing is a very serious problem, because we have not yet got a machine which can be slowed up and will then strike the water with comparative safety in a choppy sea. You have got to go with a certain amount of force, and that is one of the great difficulties in getting pontoons underneath that will stand that strain of hitting a choppy sea or striking the water, and that is a thing with which we are constantly beset, but we are making progress in getting pontoons that will answer the purpose."

Henry Souther, head of the inspection corps of the Army Aviation Section and a recognized authority on gasoline engines, also appeared before the committee and said:

"Last May, when I entered the service of the Army, I was repeatedly told that there were no good motors, and I approached the problem with that in mind. A small board of officers was selected from the Aviation Section of the Army and all the principal engine builders were visited. I came home from that visit fully convinced that although there might not be any perfect engines at the moment, there was no earthly reason why there should not be many perfect engines in the very near future."

Mr. Souther mentioned specifically the Curtiss VX, the Hispano Suiza, built by the Wright-Martin Aircraft Corporation and the 9-cylinder 125-horse-power Gnome engine which is being made by the General Vehicle Company in Long Island City as successful engines now being constructed in the United States. He also stated that the Army contemplated beginning work on the development of a Zeppelin.

Captain J. S. McKean, in charge of aviation in the Navy, was called by the committee to explain his request for $5,133,000 for naval aeronautics. At the date on which he testified, December 1, the aeronautic equipment of the United States Navy was, he said, distributed as follows:

"There are in use at the Pensacola aeronautic station the following: Airplanes, 12; lighter-than-air craft, 2; on board the *North Carolina*, airplanes, 2; ready for service on board the *Washington*—she went to sea without getting them and they are at Portsmouth, N. H., awaiting her return—5; on board the *Nevada*, 1 kite balloon; on board the *Oklahoma*, 1 kite balloon."

Captain McKean brought out the fact that the Navy General Board originally estimated that $6,000,000 would be needed for naval aeronautics next year, but that the Secretary of the Navy, acting upon Captain McKean's advice, had decided to cut this sum to $5,133,000 because of the lack of available sources of supply for both personnel and material. The General Board also recommends the following machines be constructed immediately: 75 small seaplanes, 75 large seaplanes, 7 small land airplanes, 5 kite balloons, 20 non-rigid dirigibles for patrol work, and 1 rigid dirigible.

Captain McKean concluded his testimony by introducing the following estimates for aeronautics for 1918:

ESTIMATES FOR NAVAL AERONAUTICS, 1918:

The following are detailed estimates in accordance with total estimate of $5,133,000, which it is understood has been accepted as the preliminary estimate for aeronautics, 1918:

Fleet:	
30 airplanes at $18,000	$540,000
Spare parts, operation, and maintenance for above	448,200
	$988,200
Naval Militia:	
12 school airplanes, at $9,000	$108,000
Spare parts, operation, and maintenance for above	89,840
	$197,840
Marine Corps:	
One advance base unit—4 airplanes, at $18,000	$72,000
Spare parts, operation, and maintenance for above	59,760
Two kite balloons	8,000
Hydrogen-generating set and storage cylinders	50,000
Hangars, runways, and shops	50,000
Tool outfits, etc	45,000
	$284,760
Pensacola aeronautic station:	
40 airplanes, at average price $12,000	$480,000
Spare parts, operation, and maintenance for same	398,000
Station maintenance	70,000
	$948,000
Pacific coast aeronautic station: Cost of development, including improvements to grounds, water front development, hangars, shops and power plant	$750,000
Pearl Harbor station: Same as for Pacific coast station	500,000
Canal Zone: Army has been requested to add $250,000 to sundry civil bill for development of Navy aeronautic station on Canal Zone	None.
Lighter-than-air craft:	
2 large dirigibles	1,000,000
2 hangars for same	250,000
Hydrogen plants	200,000
	$1,450,000
Total of items listed above	$5,119,200
Miscellaneous	13,800
Grand total	$5,133,000

Dr. Charles D. Walcott, a member of the National Advisory Committee for Aeronautics, told of the work of the committee and outlined some problems in aeronautics yet to be solved.

The S. A. E. Meets on January 11

The annual meeting of the Society of Automobile Engineers will be held at the Engineering Societies Building, New York, on Thursday, January 11. At the morning session, which will be called to order at 10.00 a. m., formal business will be transacted and the results of the election of officers for the ensuing year will be announced. A buffet luncheon will be served in the building at 12.30 p. m., and at 1.30 p. m. Captain Virginius E. Clark, U. S. A., is scheduled to read the first paper of the Professional Session.

Captain Clark's subject is: "Some Problems in Airplane Construction," and it is anticipated that he will cover some of the Army experiences in operating airplanes on the Mexican border, and will use these experiences as a basis for suggesting changes in design necessary for securing a more satisfactory military airplane.

"Aerial Navigation Over Water" is the subject of the paper that Elmer A. Sperry is scheduled to present at 3.30 p. m. While ordinary flights are made over land by the guidance of landmarks, other means must be employed in flying over the sea. Mr. Sperry's paper discusses fully such means and their use, and goes into the troublesome matter of drift and absolute headway.

Meetings of the various divisions of the Standards Committee will be held on January 9 and 10.

Pan-American Aeronautic Exposition

Howard E. Coffin, of the Naval Consulting Board of the United States, who also is chairman of the Pan-American Aeronautic Exposition Show Committee, has been in Washington, where he has met and talked with numerous prominent government officials on the prospects of the approaching Aeronautic Show and how it will act as a stimulus toward the establishment of adequate aerial defense in this country.

This first Pan-American Aeronautic Exposition is not to be a mere "show," but rather a comprehensive exhibition of what remarkable strides have been made in aircraft construction during the last few years, particularly since the war began, and is to become a permanent annual fixture, more in the nature of an institution than a show, for the influence of these expositions will be felt from one year to another throughout the aeronautic world. It will become the great clearing house for the industry and afford a convenient means of cooperation of the many interests connected with aviation and aerial military and naval defense, besides giving the general public an opportunity to keep pace with the development of this latest science.

"The exposition will afford a splendid object lesson in practical national preparedness," declared Mr. Coffin in Washington a few days ago. "Furthermore, it will be intensely interesting to all classes of people. When you stop to think for a moment, do you realize that the great mass of Americans have never even seen a modern airplane or balloon? Aside from people who live in cities where these are made or tested, the public only knows what they look like from war pictures in newspapers and magazines, and most of these pictures are so small that they do not convey any idea of the manner in which the craft operates.

EXHIBITS INTERESTING

"These exhibits of planes, kites, balloons, dirigibles, and their many accessories, will be interesting not merely to the technical student and military officer, but to the layman as well. Not only will adults be inspired by this exhibit, but schoolboys and schoolgirls as well will want to see it. It is perfectly astounding the amount of interest some school youngsters are taking in aviation and how much they have learned about the modern airplane and its workings. Many of these will be active in the aviation world a few years hence.

"The importance of this great exposition may be realized when the fact is revealed that the military authorities of practically every European and South American government will send representatives to the exposition to observe what America is producing. Then, too, the two appropriations of Congress, aggregating $45,000,000, for two years, for the building of aerial defenses, will act as a great incentive to manufacturers of aerial craft and accessories who are anxious to bring the merits of their products to the attention of the government and the general public. Many of these makers will exhibit at the show —some of them quite new to the aviation industry.

REASON FOR GREAT INTEREST

"Another reason for intense interest in the exposition is that commercial air lines are now about to be established. Within a short time—certainly within five years—there will be corporations operating passenger air lines between New York and Chicago, and between other cities as well. The remarkable development of the high-powered airplane capable of carrying many passengers, and the ability of dirigible constructors to harness and control their huge bags of gas, mean that commercial air lines within a short time will be operating air machines on schedule about as regularly as the Twentieth Century Limited. Imagine how keenly these promoters will watch what is brought out at the annual expositions!

"The aeronautic industry at present is quite analogous to the automobile industry of some fifteen years ago. What was considered as impossible in those days is most commonplace today, and what we consider startling in the aeronautic field to-day will be an everyday sight a few years hence."

SANCTIONED BY MOTOR AND ACCESSORY MANUFACTURERS

For the first time in its history the Motor and Accessory Manufacturers' Association, which includes in its membership more than 240 leading manufacturers of automobile and airplane accessories, has sanctioned its members exhibiting at a show or exposition outside of the annual national automobile shows in New York and Chicago. On December 30, the association, through its Board of Directors, agreed to sanction the first Pan-American Aeronautic Exposition, and a number of its members will exhibit in a body in a large space set aside for them in an area of about 75,000 square feet.

Many members of this association, such as makers of carburetors, spark plugs, motors, motor parts, radiators, magnetos, electrical apparatus, etc., are already selling their products to the constructors of airplanes, and the action of the association is due to the fact that it realizes the important position aeronautics will occupy in American industrial life in the near future.

The Automobile Chamber of Commerce, many of whose members are constructing experimental airplane engines, while it has taken no official action, is lending its moral support to the Aeronautics Exposition.

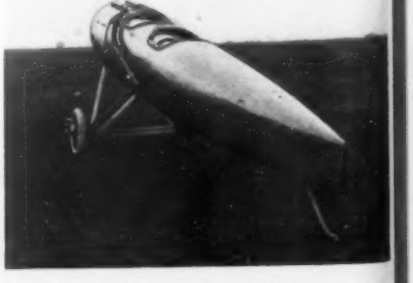
SOME OF THE EXHIBITORS

Every foot of space on the first exhibition floor of the Grand Central Palace and two-thirds of the second floor has already been contracted for by exhibitors, and at the rate applications are coming it is confidently predicted that much of the third floor will also be required.

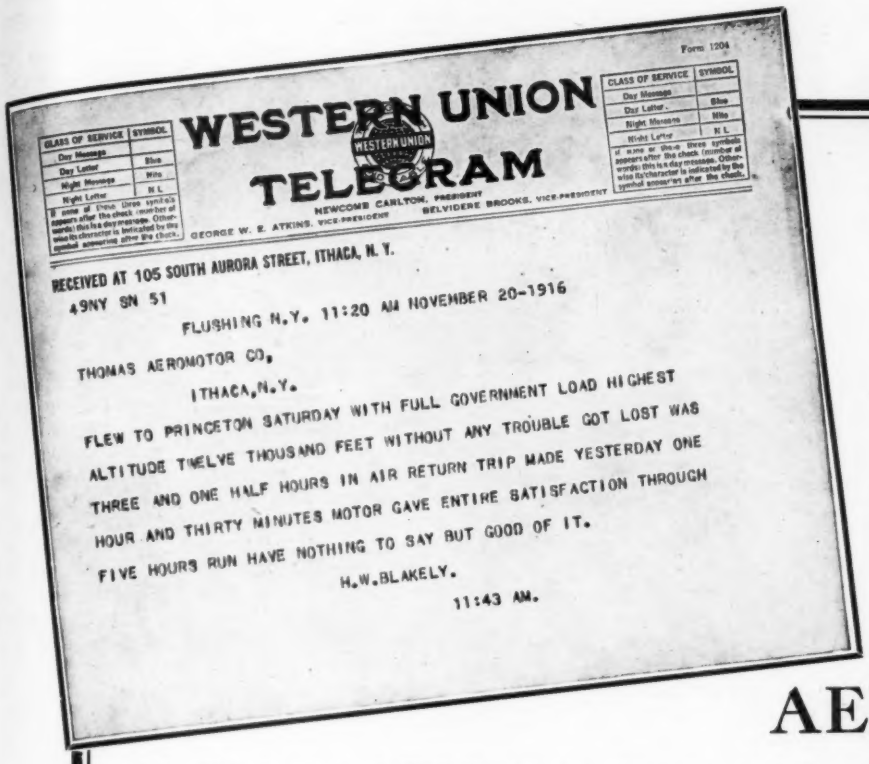
Some of the companies who will exhibit are: Aeromarine Plane and Motor Company, Curtiss Aeroplane and Motor Corporation, John D. Cooper Aeroplane Company, L. W. F. Engineering Company, Samuel S. Pierce Aeroplane Company, The Sperry Gyroscope Company, Standard Aero Corporation, Thomas Bros. Aeroplane Company, Wright-Martin Aircraft Corporation, Knox Motors Company, Packard Motor Car Company, Hudson Motor Car Company, Connecticut Aircraft Company, Erie Specialty Company, The Goodyear Tire and Rubber Company, New Jersey Aeroplane Company, Roebling Sons' Company, Standard Screw Company, Martin Stabilizer Company, Motometer Company, Taylor Instrument Company, Splitdorf Electrical Company, United States Rubber Company, Valentine and Company, Wisconsin Motor Manufacturing Company, Worlds Motor Company, Sturtevant Aeroplane Company, B. F. Sturtevant Company, Motor Compressor Company, and the DuPont Chemical Works.

Two Views of the L-W-F Biplane

One of the two L-W-F biplanes recently delivered to the United States Army at Mineola after satisfactorily meeting the government tests.



The three-ply wrapped spruce monocoque body of the L-W-F biplane.



WESTERN UNION TELEGRAM

NEWCOMB CARLTON, PRESIDENT
GEORGE W. E. ATKINS, VICE-PRESIDENT BELVIDERE BROOKS, VICE-PRESIDENT

RECEIVED AT 105 SOUTH AURORA STREET, ITHACA, N. Y.

49NY SN 51

FLUSHING N.Y. 11:20 AM NOVEMBER 20-1916

THOMAS AEROMOTOR CO,
ITHACA,N.Y.

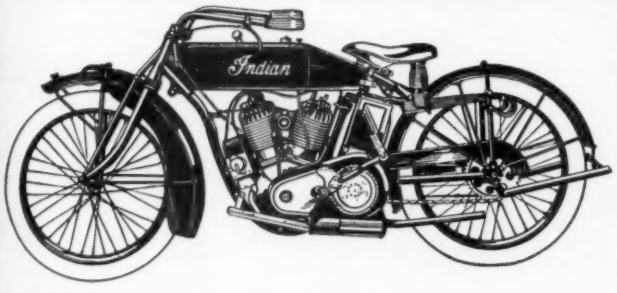
FLEW TO PRINCETON SATURDAY WITH FULL GOVERNMENT LOAD HIGHEST ALTITUDE TWELVE THOUSAND FEET WITHOUT ANY TROUBLE GOT LOST WAS THREE AND ONE HALF HOURS IN AIR RETURN TRIP MADE YESTERDAY ONE HOUR AND THIRTY MINUTES MOTOR GAVE ENTIRE SATISFACTION THROUGH FIVE HOURS RUN HAVE NOTHING TO SAY BUT GOOD OF IT.

H.W.BLAKELY.
11:43 AM.

Just a Line *of* Appreciation From One Who Knows THOMAS AEROMOTORS

Mr. Blakely of the L-W-F Engineering Company of College Point, N. Y. has now been flying their machines equipped with *Thomas Aeromotors* for approximately six months. The above telegram speaks for itself.

THOMAS AEROMOTOR CO., Inc. ITHACA, N. Y.



The Aero Squadrons of the Aviation Section

of the Signal Corps of the United States Army now are using fourteen 1917

Indian Motocycles

The certainty of Indian performance and excellence of construction are indispensable to the duties of this branch of Uncle Sam's fighting machine.

The Indian's great strength, ease of control, speed, power, and mechanical simplicity lend themselves admirably to the urgent requirements of the army's flying men.

With a view to developing special motorcycle equipment for this important work, the Hendee Manufacturing Company will be glad to consider suggestions from military officials.

Fully illustrated and descriptive 1917 Indian Catalog sent anywhere on request.

HENDEE MANUFACTURING COMPANY

(*Largest Motorcycle Manufacturers in the World*)

859 STATE ST., SPRINGFIELD, MASSACHUSETTS

is now located in its NEW FACTORY on LINCOLN HIGHWAY and MEADOW STREET, PASSAIC RIVER, NEWARK

The company is equipped with the most modern facilities for filling orders for aircraft of standard and special designs

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Newark Telephone 9096 Market **New York Telephone 2461 Rector**

Resilient and Light

In the shock of rough welcome by Mother Earth, it is good to know that Goodyear Cord Tires are under your 'plane.

The cord construction gives them resiliency and strength to withstand the terrific shock of landing on rough, uneven ground—and a factor of safety greater than that of any other aeroplane tire.

The light and very strong Goodyear Rims to which they are tightly attached, insure against slipping off, even when the landing shock flattens them out.

The reputation which extensive use has given them both here and abroad is not due merely to the fact they are the only *cord* tire made for air machines.

The superior workmanship and excellent materials have played no small part in the winning of their good name; just as they have established in favor everything made of rubber which Goodyear supplies for aeroplanes or balloons.

Send us your requirements.

The Goodyear Tire & Rubber Co.
Akron, Ohio

GOODYEAR
AKRON

Pensacola Notes

First arrivals of a new class of twelve officers to go in training at the aeronautic station have already commenced work at the school, and others are expected daily. Several officers of the naval militia are also under instruction, and many flights are being made. Some of the officers permanently stationed are undergoing examinations for promotion.

Seventeen new Curtiss seaplanes have arrived from the factory, after inspection there by officers of the school, and are being tested by Lieutenant Phillips Rader, pending acceptance. Lieut. Rader was formerly with the Allied Aviation Corps, on Zeppelin duty over London. His experience in Europe renders him well acquainted with practical aeronautics, and his spectacular performances are viewed with more than the usual interest both in naval and civilian circles.

A slight accident marked the flight of Lieut. Spencer recently while testing a new machine, when, just before alighting on the surface of the bay, the machine made a nose dive, and turned over. The pilot was unhurt and the machine was only slightly damaged. A fast speed boat and two airplanes were rushed to the scene, and the wrecked machine towed to the station.

A number of flights have been made with free balloons, this work being under the supervision of Lieutenant-Commander F. R. McCrary. Since a rainstorm interrupted the first attempt, an all-night flight has not been tried, though many day flights have been made.

Harriman Aircraft Motors Incorporated

Harriman Motors Co. of South Glastonbury, Conn., has just been incorporated for $125,000, and will from now on be known as Harriman Aircraft Motors, Inc. The company will, as in the past, manufacture the original Harriman motor, with many new and up-to-date patented parts, in sizes from 60 to 150 horsepower.

The plant for the present will remain at South Glastonbury, but will be enlarged. New buildings will be erected and the necessary machinery will be provided for at once. Orders are in sight for over 200 motors of various sizes.

Beam School *of* Aviation

Offers rarest opportunity of all

New Aeroplane, exhibition type ready for motor, given to the student out of each class of ten getting his license after least number of minutes training.

FACTORY EXPERIENCE
RAPID INSTRUCTION

No charge for breakage.
Board and room very reasonable.

Instruction under Billie Brock and Monte Rolfe, Loopers

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Radium Compound No. 6

is specified in United States Government "Aeronautical Specification No. 1002." For

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Barometers Clocks Compasses
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WE ALSO MAKE OTHER GRADES OF RADIUM COMPOUND

Send us an instrument for specimen treatment

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Military and Sporting Land and Water Aeroplanes

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Fahrig Anti-Friction Metal

The Best Bearing Metal on the Market
A Necessity for Aeroplane Service

Fahrig Metal Quality has become a standard for reliability. We specialize in this one tin-copper alloy which has superior anti-friction qualities and great durability and is always uniform.

When you see a speed or distance record broken by Aeroplane, Racing Automobile, Truck or Tractor Motor, you will find that Fahrig Metal Bearings were in that motor.

FAHRIG METAL CO., 34 Commerce St., N.Y.

Aero Club of Pennsylvania

At a recent meeting of the Aero Club of Pennsylvania, a large audience listened to Major William Mitchell, U. S. A., lecture on "Military Aviation." Aviation conditions in America are worse than in Europe because of our geography and economic development, according to Major Mitchell.

"Extensive cultivation such as we have, and large areas of undeveloped land, added to the difficulty of finding good landing places," he said, "place us far behind the battlefields of Western Europe as an aviation-testing center.

"Every factory in this country is swamped with government orders for airplanes. Orders have been placed for a new battle triplane of a speed of 119 miles an hour and armed with one machine gun. We hope also to get a scout plane in the near future capable of over 150 miles an hour. Dirigibles for reconnaissance at sea are under consideration by the Navy, but government engineers have been unable as yet to duplicate the peculiar aluminum steel needed for their manufacture.

"Engineers and aviation instructors are also badly needed," Major Mitchell explained. "Few of the civilian schools can properly train men for Army work."

The annual meeting of the club and election of officers will be held in the Bellevue-Stratford on the evening of January 19, and a large attendance of members is earnestly requested.

Ajax Radiator Used on Many Hall-Scott Engines

A radiator section, claimed by the manufacturer to be one-third lighter and to contain more water than other aviation radiator sections, is made by the Ajax Sheet Metal Auto Parts Company, 245 West 55th Street, New York. The Ajax Company has under construction 85 of these radiators for the Hall-Scott Company, the Standard Aero Corporation and the Aeromarine Sales and Engineering Company. The company is making exhaust and intake manifolds for aviation engines, and has orders for nine exhaust manifolds for engines which will drive the new sea-sleds designed to develop 40 miles per hour which the Army will use as tenders for the twin-engined seaplanes it has ordered.

DU PONT

The Standard Dope
for
Aeroplane Surfaces

DuPont Dope is used on over 90% of the machines built in this country for U. S. and foreign governments.

DuPont Dope deposits a tough, flexible, and waterproof film that imparts great strength to the fabric, with correct shrinkage.

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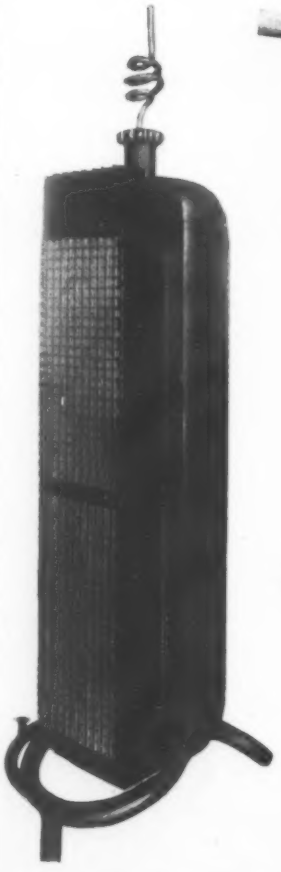

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Manufacturers
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Factors of Safety

These Count in Aeroplane Construction

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Cellulose Acetate Base

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provide another SAFETY FACTOR

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Transparent — Waterproof

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Fittings,
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Forewarns and Prevents Stalling

Accurately indicates the relative wind pressure, the force that holds the plane in the air.

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For Your Flying ← Boats Use

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BENOIST

Cross-Country planes and flying-boats have six years' actual building experience back of them.

Four Standard Models. Single and Twin motored three to seven passenger machines.

On application by interested parties, we will submit specifications on triple and four motored machines carrying as many as twenty passengers, and guarantee performance.

Benoist Aeroplane Company
SANDUSKY, OHIO

Burgess Twin-Engined Seaplanes

The Burgess Company of Marblehead, Mass., has announced that the twin-engined seaplanes, thirty-two of which will be built for the United States Army, will use two Hall-Scott, type A-7, 125 horsepower engines.

These machines will be the tractor type, and will have a wing span of more than 70 feet, with an overall length of between 30 and 33 feet. The machine empty will weigh nearly two tons, and the load carried will be 1500 pounds. The design also calls for a minimum speed of 45 miles an hour and a climbing rate of 250 feet a minute with full load aboard. Seats for pilot and observer are provided in the central body, which extends back, and carries on its after end the fixed tail surface and the horizontal and vertical rudders. The machine will be mounted on two floats placed beneath a center section, thus giving special stability while on the surface of the water.

Don't Scrap Aluminum Parts—Trial Bar 50c

SO-LUMINUM, new welding compound for aluminum, **does away with weak aluminum solders—perfect substitute for acetylene ½ time and cost.** Use gasoline torch. **So-Luminum Mfg. Co., 1790 Broadway, N. Y.**

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10 cents a word, minimum charge $2.00, payable in advance. Positions Open or Positions Wanted advertisements, no charge (20 words). Address replies to advertisements with box numbers, care of AVIATION AND AERONAUTICAL ENGINEERING, 120 West 32d Street, New York.

FOR SALE one 6-cylinder, 75 horse-power Roberts motor, new, never been used, with new "DV6" Bosch magneto. Guaranteed. $400.00. Address, Box 17.

MONOPLANE FOR SALE.—Nieuport with 4 cylinder V air-cooled motor, will demonstrate, or sell separately very cheap. Address, Box 18.

FOR SALE.—8-cylinder 60 horse-power Hall-Scott in good condition. Will sell for $550.00 with shipping crate, radiator, gasoline tank, propeller. Address, Box 623, Dallas, Texas.

FIRST CLASS AERONAUTICAL ENGINEER of wide experience on military airplanes desires situation as designer, inspector, or director of experiments. Address, Box 19.

AERONAUTICAL ENGINEER and experienced engine designer desires connection with reliable concern. Drafting, designing, testing, or production. Address, Box 63.

YOUNG MAN with general knowledge, now building experimental plane, desires position in airplane factory with opportunity to advance. Good references. Address, Box 15.

YOUNG ENGINEER, married, experienced machine designer, theoretical and practical aeronautical experience, desires position with reliable company. Address Box 10.

MECHANIC, and student of aviation, can make most any part of an airplane, wants position with some good company. References exchanged. Address Box 11.

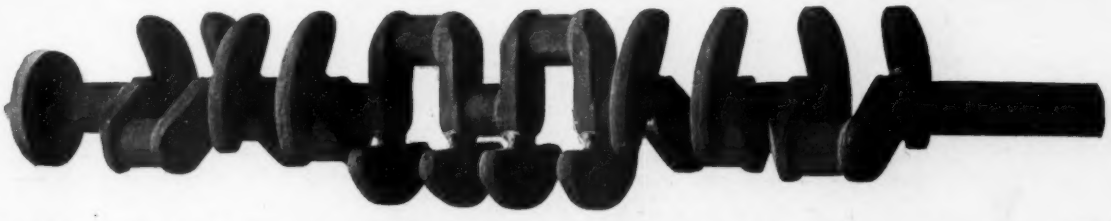
FIRST CLASS AERONAUTICAL ENGINEER of wide experience on military airplanes, desires situation as designer, inspector, or director of experiments. Address Box 19.

FOR SALE—Seven cylinder, 70 horsepower rotary motor, with Excelsior propeller. $450.00. Address Landsmann Motor Co., 1406 S. 18th St., St. Louis, Mo.

YOUNG MAN, college graduate, and thoroughly familiar with gas engines, desires position with airplane company. Best references. Address Box 9.

EXPERIENCED YOUNG AERONAUTICAL ENGINEER desires position as assistant or in charge of experimental work. Small, live company preferred. Address Box 14.

COUNTERBALANCED



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